ANNALS OF SURGERY

VOL. XXXVIII NOVEMBER, 1903 No. 5

ORIGINAL MEMOIRS.

THE SURGICAL PROBLEM IN PROSTATIC HYPERTROPHY.

BY GEORGE WALLER HAWLEY, M.D.,
OF SEATTLE, WASHINGTON.

THE hypertrophy or overgrowth of any organ, in one or all of its tissue elements, presents two morbid anatomical changes: (1) An increase in the number or size of the cells of which it is composed. (2) Displacement of contiguous structures (other organs and tissues) due to the expansion of the hypertrophied organ, for physical laws teach us that no structure, surrounded by other structures, can enlarge without displacing them. The change in the *gland itself* becomes of pathologic significance only when increased functionating power results in functional overproduction, and in the upsetting of economic equilibrium of the physiologic system to which the organ belongs and, under such circumstances, becomes clinically manifest by symptoms referable to the *organ itself*. The second morbid change, the displacement of *other organs*, only becomes of pathologic significance when such displacement causes interference with the function of the displaced organs and becomes clinically apparent by symptoms referred to them.

The rôle of the hypertrophied prostate, as a pathologic

condition,* is purely a mechanical one. It is only because its expansion causes displacement of the urethra and bladder, and thereby interference with the evacuation of urine, that it becomes of pathologic importance and clinically manifest. If hypertrophy of the prostate did not cause vesico-urethral displacement sufficient to impede urinary evacuation, it would excite no more clinical interest than the opposite condition of atrophy of the prostate. This is evidenced by the fact that hypertrophy may and does exist for many years † before its presence becomes known by urinary obstruction, and in about one-half ‡ of all cases it exists without notice or harm from the time of its inception till death in old age.

When the harmless overgrowth of any organ causes pressure displacement and disturbance of the proper function of

* The simple hypertrophic changes in the prostate also offer in moderate degree fertile conditions for carcinomatous degeneration. Greene and Brooks (*Journal of the American Medical Association*, April 26, 1902), from their histologic study upon the prostate, conclude that, while true neoplasms of the prostate are rare and have no concern in the development of hypertrophy, carcinoma is apt to arise in the hypertrophied organ. Albarran and Halle (*Ann. des. Mal. des Org. Gén.-Urin.*, February and March, 1900), in fourteen out of 100 prostates, found evidence of atypical adenoma which they considered the transformation stage from hypertrophy to carcinoma. Oraison (quoted in *Journal of the American Medical Association*, July 25, 1903) mentions twenty-eight cases of carcinoma in a total of 306 prostatic subjects during the last three years in Neckar Hospital, a little less than 10 per cent.

† Although prostatic hypertrophy is not observed clinically and does not cause urinary obstruction till after middle life, Lydston and others advanced the belief that enlargement often began in the third decade, upsetting the creed of Thompson and the older writers, who considered enlargement essentially a senile condition, and denied its existence before the fiftieth year. Socin and Burckhardt ("Die Verletzungen und Krankheiten der Prostata," Stuttgart, 1902, p. 80) have verified this new thesis by pathologic research. Their investigations upon 300 post-mortem sections of men over thirty-six years at the Basel Institute showed prostatic hypertrophy in 101. Of those between the ages of thirty-six and forty hypertrophy was found in 13 per cent.; between forty and fifty, 25 per cent.; fifty and sixty, 31 per cent.; between sixty and seventy, 56 per cent.; between seventy and eighty, 50 per cent.; and between eighty and ninety, 54 per cent.

‡ According to Sir Henry Thompson, 34 per cent. of all men attaining the age of sixty have hypertrophical prostates, but less than half of these suffer from the disease.

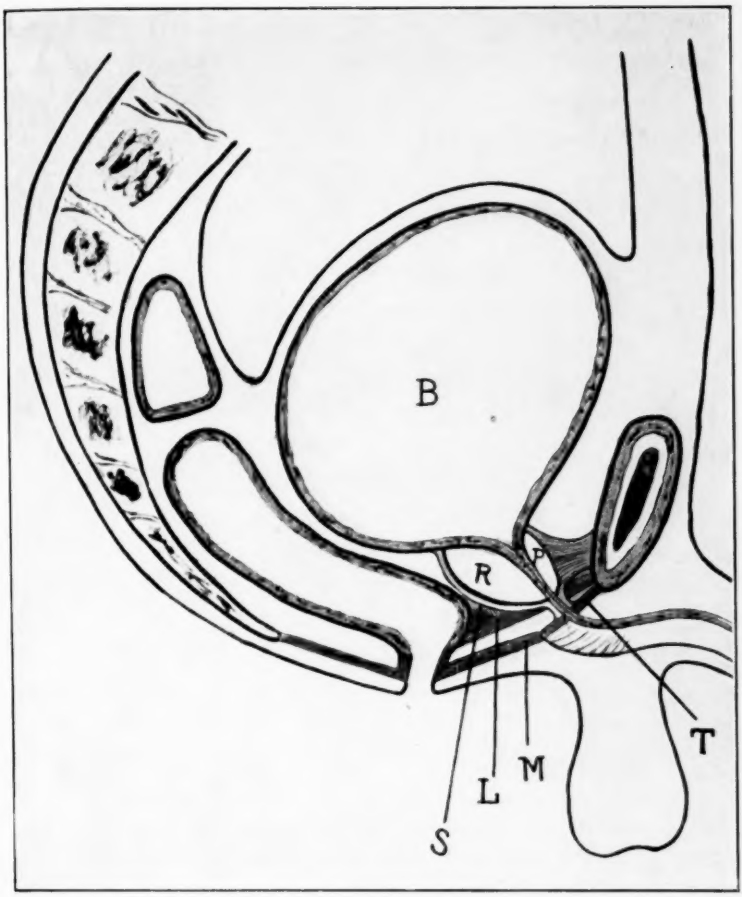

FIG. 1.—Diagrammatic sagittal section of the male pelvis showing the pre- and retro-urethral portions and their relations. R, Retro-urethral or surgical prostate; P, pre urethral prostate; B, bladder; S, prostatic sheath or ligament; L, levator ani of left side; M, recto-urethral muscle; T, triangular ligament or diaphragma urogenitale.

another organ, it is not the offending but the offended organ which requires relief. In prostatic hypertrophy, then, we are not asked to treat the prostate, but the bladder. When an organ requires relief because by displacement its function is interfered with, natural efforts of relief would be directed towards preventing displacement or correcting it sufficiently to permit of proper performance of its function.

Since the problem presented in the prevention and correction of any displacement is largely a mechanical one, requiring for intelligent solution a study of the forces producing and maintaining displacement, before considering methods of relief for vesico-urethral displacement due to prostatic hypertrophy, let us study the prostate and its surrounding structures, the mechanism of vesico-urethral displacement, and of urinary interference.

The prostate is described as a cone-shaped organ about the size of a horse-chestnut, with its base directed upward and slightly backward towards the bladder and its apex facing downward and slightly forward towards the triangular ligament. It has two lateral lobes and two commissures,—the anterior commissure joining the lateral lobes in front, and the posterior uniting them behind the urethra. The lobulated prolongation of the posterior commissure upward and backward between the ejaculatory ducts is known as the middle or third lobe of Home. The first portion of the urethra with its enclosing muscle, the sphincter urethræ prostaticus (Kohlrausch), passes downward and forward between the lateral lobes of the prostate from base to apex directly behind the anterior commissure. In relation to the urethra, the prostate can be divided into the *pre-* and *retro-urethral* portions, four-fifths to five-sixths of the gland lying behind the axis of the urethra and only the small anterior commissure in front. This relation is important as regards displacement of the bladder and urethra. The prostate is composed of glandular, muscular, and fibrous tissues. The former is distributed almost wholly in the lateral and middle lobes, the anterior isthmus or commissure containing but little, being composed almost en-

tirely of muscular and fibrous tissue, which are also distributed irregularly throughout the rest of the organ from the periphery to the urethra. The fibrous tissue spreads out on the periphery to form the dense true capsule of the prostate. Externally, the prostate is surrounded (except its base, which is placed directly against the bladder) by a strong fascial sheath reflected from the posterior layer of the triangular ligament from the apex to the base of the prostate, and thence upon the bladder. This sheath encloses the prostate like a collar and, where it meets in front, passes forward to the pubes to form the puboprostatic ligament. This collar-like sheath with its attachment to the pubes serves as the suspensory ligament of the prostate, holding it up, and with it the neck and floor of the bladder.* This sheath has also been called the capsule of the prostate, but cannot rightly be so considered because it is not derived from the prostate but from the pelvic fascia; it does not surround the whole organ but only its sides, and is but loosely joined to it. Of other relations to the prostate, we have the bladder floor and neck above; the pubes and pubic arch supporting the triangular ligament in front; the inner separated margins of the levatores ani and the rectum and posterior half of the perineum below; and the rectum and the ejaculatory ducts behind.

The Mechanism of Vesico-Urethral Displacement.—The displacement of the bladder and urethra resulting from prostatic enlargement depends primarily upon the relation of the portion which enlarges to the urethra and bladder. Thus the *pre-urethral portion,* situated in front and above the neck of the bladder and urethra, can only cause displacement backward and downward, while the *recto-urethral* portion, situated behind and below the urethra and vesical neck, results in upward displacement. While great expansion of the pre-urethral prostate might result in marked displacement, as a

* Retzius evidently ascribed this function to the prostatic sheath when he named it the ***ligamentum pelvioprostaticum capsulare.***

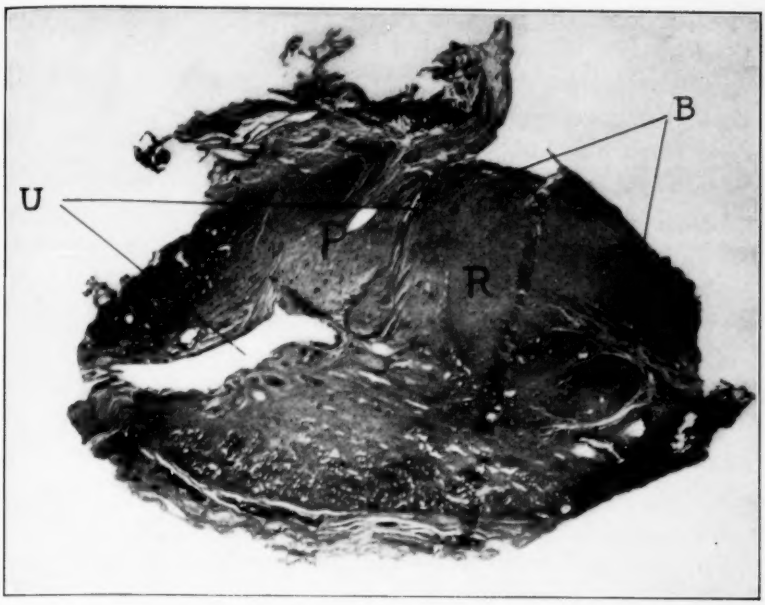

FIG. 2. Sagittal section of an enlarged prostate (actual size) showing vesico-urethral displacement. R, Retro-urethral prostate; P, pre-urethral prostate; B, bladder-floor; U, urethra.

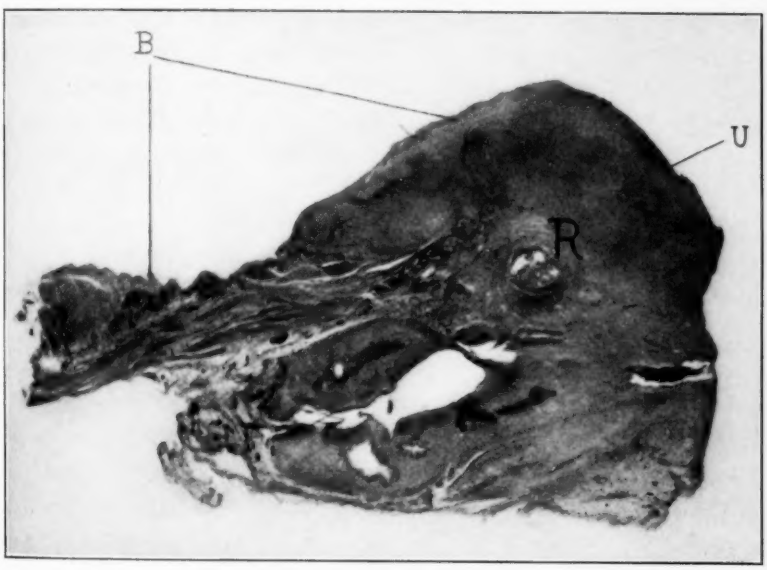

FIG. 3.—Sagittal section of enlarged retro-urethral prostate (actual size) showing elevation of vesical outlet and distortion of prostatic urethra. R, Retro-urethral prostate; B, bladder-floor; U, urethral floor.

matter of fact, the enlargement of this portion of the prostate is usually slight, and the resulting downward displacement is not noticeable nor important, and is entirely ignored in operative procedures, even in prostatectomy. The enlargement of the pre-urethral portion is small because of the infrequent occurrence of glandular tissue within it, and seems small in comparison with the enlargement of the portion of the prostate behind the axis of the urethra,—the *retro-urethral* part,—representing by far the greater portion and comprising the two lateral lobes and the posterior commissure with its so-called middle lobe. The expansion of any or all of these portions, lying as they do behind the axis of the urethra and below the neck of the bladder, would result in displacement upward of the vesical neck and floor, and elongation of the prostatic urethra with elevation of its vesical end, but the form of displacement would vary as the enlargement of the middle or lateral lobes predominated. Thus in lateral lobe enlargement we would expect greater elevation of the bladder neck and distortion of the urethra, while from middle lobe enlargement greater elevation of the bladder floor. The height of vesico-urethral elevation depends (1) on the degree of enlargement of the retro-urethral prostate and (2) the amount of resistance which the bladder and urethra exert against its expansion, in comparison with that exerted by the other surrounding structures, for greater resistance in other directions must result in greater expansion upward. If resistance was, as a rule, greater on all sides than above, we would expect to find expansion upward out of proportion to expansion downward and in other directions, and, when such resistance was extreme, upward expansion only with marked vesico-urethral elevation; but when resistance was slight, then little expansion upward even in great enlargement. And such are the anatomical findings. We occasionally observe large prostates with marked downward, and therefore but slight, vesico-urethral displacement, causing no urinary obstruction. Of those which do cause marked obstruction, we find a considerable number

with little or no downward expansion; * some small enlargements with great upward expansion; and, in the vast majority of the clinically observed cases, the downward is much less than the upward expansion. From these findings it must be inferred that were the retro-urethral prostate free to expand downward away from the urethra and bladder, prostatic hypertrophy would never cause displacement of these organs nor interfere with the evacuation of urine; that certain adjacent structures do, as a rule, resist expansion in all directions more than upward.

Of the structures placed in front of the retro-urethral prostate, the urethra, the anterior isthmus, the prostatic sheath, the pubic arch, and the triangular ligament, with the exception of the urethra, all offer sufficient resistance to prevent expansion forward. Of the inferior structures, we have first the fibrous sheath, the natural support of the prostate; then the levator ani on each side of the rectum and below, the posterior half of the perineum. Among these it must be the prostatic sheath which offers the greatest, in fact the only, hinderance to expansion downward, because, as a supporting ligament, it would oppose pressure from above, particularly against its lower portion, where it is strongest; † and since it is the only structure which can and does resist prostatic expansion laterally and behind, it must do so equally below. Opposition from the levator ani and perineum can only operate when the sheath has given way.

The mechanism of interference with urinary evacuation through vesico-urethral elevation in prostatic hypertrophy can be attributed to several factors. (1) To inefficient bladder drainage caused by elevation of the outlet of the urinary reser-

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* According to Motz, one-third of all tumefactions of the prostate cannot be diagnosed per rectum, and cystoscopic examination upon most men past middle age reveals irregular elevations of the lower margin of the vesical neck when no other signs of prostatic enlargement are present.

† Von Frisch ("Die Krankheiten der Prostata," Wien, 1899, page 1). "Zwischen Rectum und Prostata ist die Kapsel am stärksten (Fascia rectovesicalis)."

voir. (2) To incomplete emptying of the bladder through limitation of the vesical movements. Normally, the bladder outlet is on a level with its floor, so that drainage is perfect. Any elevation of the outlet raises the level of drainage, thereby requiring extra force to raise up and expel the urine below that level. The movements of the bladder are complicated; first, the neck and floor of the bladder sink slightly downward and forward,* still further lowering the level of exit and straightening the intrapelvic urethra. At the same time the vesical sphincter dilates, followed by contraction of the bladder-wall. The overgrown and encroaching prostate prevents this sinking of the outlet and renders the bladder floor rigid, inhibiting proper vesical contraction. We would expect from elevation of the bladder outlet, residual urine offering a favorable condition for stone formation and infection; from insufficient bladder contraction, a compensatory hypertrophy of the vesical musculature and frequent micturition due to the efforts of the bladder to wholly expel its contents; and a congestion of the vesical outlet and urethra from obstruction to the efferent circulation of these parts with a tendency to retention of urine. These results tally exactly with the signs and symptoms which we hold as characteristic of prostatic hypertrophy.

The Treatment of Urinary Obstruction due to Vesico-Urethral Elevation.—As was noted earlier, the logical aim of efforts to relieve the functional derangement of an organ due to its displacement should be directed towards preventing the displacement; or to correcting it sufficiently to allow the organ to functionate satisfactorily, without injury to the organ or undue risk to the patient. To prevent vesico-urethral elevation, two ways are open: (1) by the prevention of prostatic

* This phenomenon can be readily demonstrated by rectal examination. Just previous to the passage of the urine, it will be noted that the retro-urethral prostate sinks downward and forward and the bladder floor drops within easy reach. This movement of the prostate seems to follow the arc of a circle whose centre is the point of attachment of the puboprostatic ligament to the pubes, and is probably brought about by dilatation of the vesical sphincter and intra-abdominal pressure acting from above and relaxation of pelvic diaphragm below.

hypertrophy and (2) by preventing expansion upward towards the bladder. Likewise two means are at our command to correct the elevation, (1) by establishing free urinary drainage artificially and (2) by reducing the elevated bladder and urethra.

Preventive Measures.—The prevention of hypertrophy of the prostate necessitates knowledge of the exciting causes of which we are as yet in total ignorance. The many theories which have been advanced in nearly every instance have been refuted. The Guyon-Lannois hypothesis attributing hypertrophy to arteriosclerosis of the prostatic arteries was exploded by the results of Casper's * investigations. So have the findings of Socin and Burckhardt, that hypertrophy occurs very frequently as early as the third decade, controverted the beliefs of the older writers that overgrowth was part of a senile tissue change. In like manner the claims of other ascribed causes, such as gonorrhœa, congestion, etc., have met with strong contradictory evidence. Belfield ("Progressive Medicine," December, 1902) anticipates the discovery of the cause in a perverted testicular secretion; but it is difficult † to see how this could affect the prostate. It seems more rational to look for the cause in a perverted prostatic secretion, ‡ from

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* Casper found in his study of twenty-four cases of hypertrophy, arteriosclerosis of the aorta in all, of the kidney in eight, of arteria vesicalis in eight, of small vesical arteries in nine, and of the prostatic and periprostatic vessels in four.

† A perverted testicular secretion could affect the prostate in but two ways: (1) Indirectly by influencing the testicular control of prostatic nutrition and growth (White's theory), or (2) by the direct local action of the secretion upon the prostate. To reach the prostate, this secretion must pass through the prostatic ducts from the urethra. Were this possible or frequent, we would expect as well the infiltration of urine.

‡ There is probably no secretion which contains such a varied and apparently heterogeneous collection of organic and inorganic substances, and which exhibits greater variations, not only in different individuals but in the same individual at different times. There is no organ, therefore, which should be more prone to secretory perversion and to morphological change as a result of such perversion. For the chemistry of prostatic secretion, the reader is referred to the excellent article by H. Stern (*American Journal of the Medical Sciences,* August, 1903).

the chemical action of pathologic proteids resulting from irregular metabolism or derived from disintegration of the secretion, or in the unusual action of tissue enzymes. However it may be, until the exact cause of prostatic hypertrophy is known, the possibility of preventing urinary obstruction by thwarting overgrowth of the prostate is beyond any immediate hope, and our only recourse lies in diverting the direction of expansion away from the bladder.

The prevention of expansion of the prostate upward requires the removal of forces opposing expansion in other directions, in establishing a point of least resistance downward, forward, or laterally. This is anatomically easiest of execution by relieving the inferior resisting structures, thus attempting to copy those cases, sometimes seen, of great downward but with little or no upward expansion. The release of the resistance of the inferior forces is easiest, because the structures representing the resistance—the prostatic sheath, the levator ani, and the perineum—are the most accessible. This would be accomplished by division of the sheath and the edges of the levator ani through a perineal incision. This should permit of free expansion in a downward direction. The clinical application of such measures would be impracticable except in particularly early cases, because prostatic hypertrophy is rarely recognized until displacement of the bladder has occurred. Theoretically, the application of such a procedure in early cases is sound, requiring but simple operative trauma, with conditions favorable to primary wound healing before advancing years have lessened the recuperative powers, and before urinary infection with its grave sequelæ had set in.

CORRECTIVE MEASURES.

(1) *By Establishing Artificial Urinary Drainage.*—Long ago the importance of relieving urinary obstruction in prostatic enlargement and giving free exit to the retained urine was recognized, and, before surgery had come to the point of attacking the obstructing prostate, the bladder was drained artificially by suprapubic cystotomy and through the perineum. In mod-

ern times, except in extreme cases, these procedures have been abandoned, because in affording relief they create another condition almost as bad. E. Goldman (*Beiträge zur klinischen Chirurgie*, Band xxxi, Heft 1) has recently advanced a new method of artificial drainage which leaves the elevated bladder outlet and floor undisturbed, but attempts to raise the fundus of the bladder. Observing that urinary evacuation invariably improved in those prostatics upon whom suprapubic puncture had been done for retention, and concluding that this was due to elevation of the fundus from adhesions, he proposed a *ventrofixatio vesicæ*, which he has performed with some success. The mechanical principle of this procedure is correct. To raise the body of the bladder to the level of the elevated outlet would induce thorough drainage, but to do so in a collapsible organ like the bladder, weighted down with accumulating urine, by dragging up its apex and attaching it to the abdominal wall, is impossible except in such a limited degree that could only afford moderate relief, varying with the amount of elevation of the outlet. Even were it possible to satisfactorily suspend the fundus of the bladder, the operation could never prove so successful in its results as one which reduces the vesical elevation and brings about normal urinary drainage.

(2) *The Reduction of Vesico-Urethral Elevation.*—This is the only logical plan, both anatomically and mechanically, for the correction of this condition. By reducing the elevated neck and floor of the bladder, we would expect to obliterate the retroprostatic pouch, to establish normal urinary drainage by straightening the intrapelvic urethra, and by bringing the level of the exit of the urinary reservoir down to its lowest point. As a result, we would expect complete evacuation at micturition with no residual urine; relief of muscular overstrain in the effort to overcome obstruction with cessation of vesical hypertrophy; and conditions favorable to either preventing or curing urinary infection since the infection soil, the residual urine, is removed. The remote effects of obstruction and infection, hypertrophy of the bladder, etc., are beyond aid, though they may be prevented. To reduce the vesical elevation has been

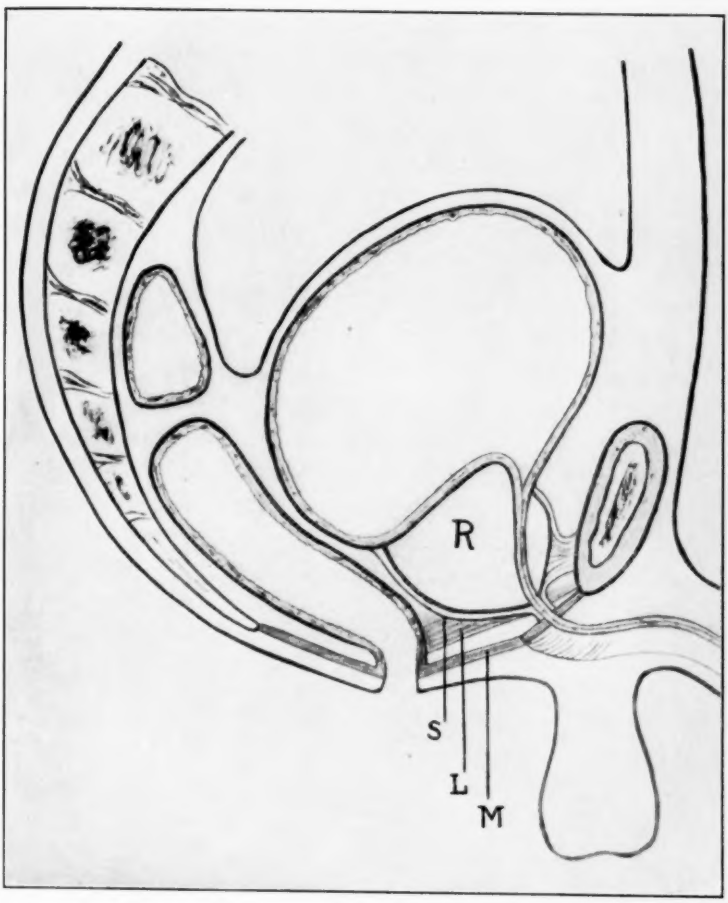

FIG. 4.—Diagrammatic sagittal section of male pelvis showing vesico-urethral elevation due to enlargement of the prostate and the structures supporting the elevation. R, Enlarged surgical prostate; S, prostatic sheath; L, levator ani; M, recto-urethral muscle.

the real, if not conscious, aim of almost all operative measures, new and old; but from the beginning the high mortality * has hindered all but the bold or enthusiastic, and has caused a strong prejudice in the minds of all conservative surgeons despite the improved technique of prostatectomy and allied procedures. The reason of such mortality has been thoroughly understood; the advanced age of the subjects when renal insufficiency and arteriosclerosis are almost certain, and when resistance to operative shock, to infection, and to hæmorrhage is lowered; and when the ureters and kidneys are often infected.

From radical methods surgery turned to moderate ones in the hope of evolving an operation which would be both effectively curative and safe. From failure in these temperate procedures, because of the hopelessness of their ever proving successful and even because of their surprising mortality, the tide has again turned to radical measures in the endeavor to lessen the dangers by improvements in technique. For the operative relief of urinary obstruction in prostatic hypertrophy will never serve its true purpose until it can be applied easily and safely in early cases before urinary infection, catheter-life, retention,

* SOCIN AND BURCKHARDT'S TABLE.

Operation.	Author.	Number of Cases.	Improvement of Complications and great Improvement of Function.	Noticeable Improvement.	No Relief.	Deaths.
			Per cent.	Per cent.	Per cent.	Per cent.
Castration.....	Emil Burckhardt.	210	69 (32.8)	64 (30.4)	43 (20.4)	34 (16.2)
Vasectomy	Emil Burckhardt.	252	62 (24.6)	87 (34.5)	82 (32.5)	21 (8.3)
Angioneurectomy	Emil Burckhardt.	18	(5.5)	(77.8)	(11.1)	(5.5)
Bottini.....	Freudenberg	690	No mention.	597 (86.5)	57 (7.8)	39 (5.6)
Suprapubic prostatectomy	Burckhardt.....	77	11	20	24	16
Perineal prostatectomy	Burckhardt.....	53	No mention.	(60.1)	(28.9)	(12.2)

and reduced vitality of advancing age have set in, before urinary obstruction has wreaked its fullest harm. Until it has reached such a stage of perfection that it can be universally applied to incipient cases, and thus prevent the grave consequences of obstruction and infection, operative procedure must be one of last resort, justifiable only in selected cases and in the hands of the skilled, and not before then will it have any place among the standard and elective operations.

To reduce any elevation requires the release of forces maintaining it, and the greater the height the more extensive must be the removal of these forces. While there may be many ways of reducing an elevation, the one which is simplest, safest, and yet effective must hold, especially when injury to the elevated structure is to be avoided and the necessary damage minimized. The forces maintaining vesico-urethral elevation are represented by the structures situated beneath it. Of these, first comes the retro-urethral prostatic mass and, immediately enclosing this below, the strong, supporting prostatic sheath or ligament. These two structures represent the chief support of the elevated urinary organs. Below them we have the separated levatores ani with the rectum between, and the posterior half of the perineum filled in by the recto-urethral muscle, with the fascia and skin externally. With but few exceptions, the great variety of operations now in vogue attempt vesical reduction by directly and indirectly releasing the *prostatic support* through shrinkage of the *retro-urethral prostatic* mass or through removal of it.

Operations for Shrinkage of the Prostate.—Theoretically, reduction by prostatic shrinkage would be ideal could it be made extensive enough to bring about complete reduction without great injury and risk. The operations having this end in view include the so-called sexual * operations (castration, vasectomy,

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* The Russian, Professor Sanitzin, of Moscow (1886), was the first to clinically demonstrate a case of decrease in size of an enlarged prostate following castration.

Fredrik Ramm, the Norwegian, was the first to *experimentally* note

angioneurectomy, etc.) and Bottini's galvanoprostatotomy with its numerous modifications. The sexual operations are based on the fact that empirically some prostates do shrink, and that experimentally atrophy of the glandular tissue of the prostate results. The degree of shrinking must vary with the proportion of glandular tissue in the hypertrophied organ. In pure adenomata, which are rare, we would expect complete diminution in size, but in the large majority, where considerable increase in the fibromuscular tissue exists, only such slight decrease in size as would but slightly influence the elevated bladder. That such is the case is substantiated by the small percentage of cures and the large proportion of "improvements" recorded. Even were the resulting atrophy greater, the operative risk is by no means small. The sexual operations must soon find an early abandonment.

The Bottini * principle relies on shrinkage by the actual destruction of a certain amount of prostatic tissue and by the resulting contraction of the scar tissue. It attacks the uppermost portion of the retro-urethral prostate, the so-called obstructing mass. It does diminish the size of the protruding mass, but only to a degree, and cannot do so thoroughly without extensive destruction. As would be expected, it results in improvements varying with the amount of the vesical elevation. Besides its failure in causing effective reduction, it necessitates injury to the bladder, which sometimes extends to other structures, as the ureter and rectum, and even under improved

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prostatic atrophy after castration and to perform this operation with purpose aforethought (April, 1893).

But to White, of Philadelphia, belongs the credit of the extensive introduction of the sexual operations upon wide and thorough experimental work.

Following castration came ligation of the spermatic cord (Erving Mears, 1894); division of the cord (Lauenstein, 1895); excision of cord (Pavone, 1895); ligation of vas (Tilden Brown, 1896); division of vas (R. Harrison, 1896); vasectomy (Lennander, 1897); and angioneurectomy (Albarran, 1897).

* The late Bottini, of Pavia, working on Mercier's principle of prostatotomy, designed an instrument (the galvanoprostatic incisor) for performing prostatotomy with a cautery blade (1874). Many modifications

methods of application it is unsurgical and productive of no small death-rate.

These many and varied operations attempting the removal of the obstruction, or, more accurately, the reduction of the vesical elevation, by shrinkage of the retro-urethral prostate represent the conservative digressions of surgery in reaction from radical measures. While curative, if they could decrease the prostate to normal, the actual decrease is invariably so slight that they can never avail of more than uncertain and unsatisfactory improvement. It is this "improvement" which has encouraged continuance of these procedures, but to produce uniform and complete reduction appears anatomically impossible.

Operations for the Removal of the Retro-Urethral or*

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of the Bottini incisor have followed upon the original, the most important ones being the cystoscopic instruments of Freudenberg and Bierhoff, and of Jacoby. But more important have been the modifications of technique. Kümmel first argued the value of visual guidance in applying the cautery, and in 1889 practised galvanoprostatotomy per suprapubic cystotomy. Belfield and Wishard (1890) carried out the same idea through a perineal section, and Chetwood has recently perfected this procedure and devised a new instrument to this end.

* Records show that Guthrie, the English surgeon, was probably the first (1834) to execute prostatectomy which was performed by the perineal route. Two years later the French surgeon, Amussat, removed the prostate by the suprapubic approach. Although suprapubic prostatectomy was performed by Dittel in 1880, it was not resurrected successfully until 1886 by Belfield and by McGill (1887). While supported for a time, of late the great majority of its adherents, with the prominent exception of Freyer, have abandoned this route for the perineal.

Although perineal prostatectomy was practised at intervals, Fergusson (1848), Keyes and Socin (1874), it has not experienced any special degree of development until quite recently. Belfield (1890) introduced the combined suprapubic and perineal method, and Nicoll (1894) modified it by excision without first opening the urethra. Alexander (1896) advocated the combined method, adding perineal drainage and enucleation by the finger from the urethra. Albarran and Hugh H. Young have still more perfected perineal prostatectomy by reducing the injury to the urethra, bladder, and ejaculatory ducts. The lateral perineal method was proposed by Dittel (1890) after experiments on the cadaver, and was first performed by Küster (1891). Prostatectomy was accomplished per rectum by Schuh in 1856 and reintroduced by Robertson, of California, in 1891. But these last two methods have never received much support.

Surgical Prostate.—Several methods have been devised to this end, and are classified, according to the route by which exposure of the prostate is obtained, into the median and lateral perineal prostatectomy, combined suprapubic and perineal, suprapubic, and rectal. The first three execute removal through the perineum, while the latter approach through adjacent viscera; the suprapubic requiring two incisions into the bladder before the prostate is reached. Each method removes by excision or enucleation the obstructing mass, the retro-urethral prostate. The remote and harmless pre-urethral prostate is untouched. The principle upon which prostatectomy is curative is radical in the extreme. It not only accomplishes, but exceeds the requirements. The elevated floor and neck of the bladder only require reduction to their normal level. Prostatectomy does this and more. It removes the support which the prostate and its sheath naturally furnish to the neck of the bladder. The operations for the removal of the prostate succeed where the conservative ones fail in that they effectually reduce the elevation, but, whereas the latter are attended with comparatively little risk, prostatectomy is notoriously a grave operation. It is undeniably true that the technique has greatly improved, especially the perineal operation performed by Albarran and the French school, and Young, of Baltimore, and that the mortality has been reduced in the hands of a few in selected cases. Yet prostatectomy has not been sufficiently shorn of its dangers to qualify its general application as some claim. Moreover, the injury to the bladder and urethra is not infrequently permanent. Enucleation of the surgical prostate is practically impossible without damage to the urethra and neck of the bladder, and permanency of this condition is far more common than supposed. Incontinence and loss of urinary control are the result and, though perhaps a less serious condition than the original, are very distressing. Published reports mention cure, improvement, or non-improvement of the urinary obstruction with exceptional reference to this untoward sequela. It must be said, however, that prostatectomy has gained new advocates, and that consensus of opinion declares its value in chosen cases. In

the failure of conservative methods it will surely survive. The criticism of prostatectomy from a mechanical stand-point is that it attempts the reduction of an elevated structure by attacking the highest and most inaccessible supporting structure, and one which is adjacent and adherent to it, and that in so doing it necessarily injures the vesical elevation and exceeds the required reduction by removing the natural inferior vesical support. In other words, it attempts a mechanical task by the most difficult means.

Two New Operations removing the Inferior Supporting Structures.—As was noted, the structures supporting the vesical elevation, besides the overgrown retro-urethral prostate, are the prostatic sheath, levatores ani, and perineum. Two operations, avoiding the uppermost but attacking the lower ones, have been proposed. E. W. Andrews (*Journal of American Medical Association,* October 18, 1902), arguing that were the prostate freed from the fixed space behind the pubes it would expand and cure obstruction, devised an *infrapubic section,* through which he divides the levator ani of one side and the puboprostatic ligament, and removes extra-urethrally a segment of the pre-urethral prostatic ring. This procedure releases but slightly two of the inferior supporting structures,—the levator ani on one side and the prostatic sheath above, and not where it can result in much reduction. The mechanical criticism of this method is that it does not attack the sheath and pelvic muscle from below at the point where they exert greatest support and are easiest of approach. Moreover, the degree of reduction obtained would be inadequate.

The second operation is that of H. Delageniere (*Archive Provincial de Chirurgie,* 1902), and called by him *subperineal prostatopexy* or *dislocation of the prostate.* The feature of this operation is that the retro-urethral prostate, after being freed from the capsule or sheath below, as in perineal prostatectomy, is drawn or dislocated downward. The principle involved is that the most important supporting structure, the sheath, is removed, permitting the prostatic mass above to sink, and with it the elevated bladder floor and urethra. Whether the reduc-

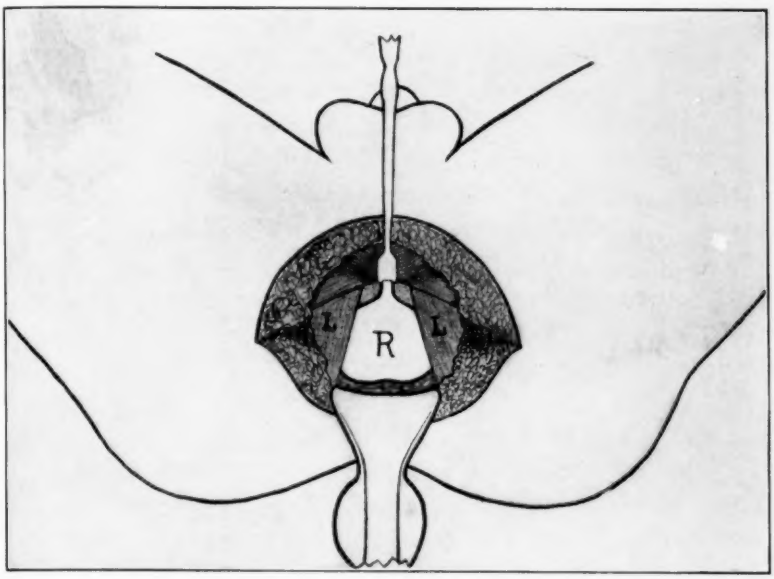


FIG. 5.—Diagrammatic sketch of the field of operation after liberal perineal incision and division of recto-urethral muscle. Kocher's inverted V, Senn's inverted Y, or Zuckerkandl's horseshoe incision (as above) are necessary for adequate exposure. Division of the margins of the levatores (L) on each side is not difficult, and can be limited to the width of the retro-urethral prostatic mass (R). Longitudinal or transverse incision of the prostatic sheath with digital stripping of it from the lower and lateral surfaces of the prostate permits eversion of the latter downward. Removal of segments of the outer and lower portions of the lateral lobes is possible without injury to the urethra, ejaculatory ducts, or bladder. Sections sliced from the lateral surfaces of the retro-urethral prostatic mass narrow it, and allow it to drop between the levatores ani, while sections from the inferior surface bring about greater dislocation downward of the upper protruding mass.

tion obtained is sufficient depends upon the height of the elevation. That it must often fail is evidenced by the author's recommendation that it gives way to total enucleation in enlargements of much size.

Mechanically speaking, the principle of these two operations is correct in that by removing the inferior support it induces reduction without injury to the elevated structures, the bladder and urethra. But they do not go far enough, and no method can be successful which does not permit of complete reduction for all degrees of elevation.

The Problem of reducing Vesico-Urethral Elevation.—As was noted, the reduction of the elevated vesical neck and urethra requires release of the supporting structures maintaining such elevation, viz., the overgrown surgical prostate, the levatores ani, and the perineum. How can this be accomplished in the easiest manner and yet effectively and without injury to the elevated parts or undue risk? Mechanic principles teach us that the task of reducing an elevation is usually most simply and completely performed by removing first the lowest and most accessible support, then the next higher, and so on, till the required reduction is obtained; that we should expect to find the simplest method in removing perineal support, then the levatores, then the prostatic sheath, and, if necessary, segments of the lower portion of the prostate sufficient to permit downward displacement of the upper protruding portion. Anatomically, such a procedure seems to bear out the mechanical claims. Release of the support of the perineum and levatores ani would induce a certain degree of sinking of the bladder floor, as rupture of the perineum does in the female, were it not that it is supported by the prostatic sheath and the surgical prostate. Release of the prostatic sheath would free the prostate of its greatest support and permit it to fall, and to fall farther than in Delageniere's operation, because more room is given the prostate to sink into by the released perineal support, and therefore to produce greater reduction. Removal of the inferior portions of the retro-urethral prostate would permit of dislocation down-

ward of the upper protruding portion, and with it reduction of the elevated bladder and urethra.

Anatomical Experiments.—To test the possibilities suggested by this study of the mechanics of reduction, I followed out the principle involved upon three prostatic subjects post-mortem. In each case Zuckerkandl's bi-ischial perineal incision was made, exposing the bulb of the urethra and the posterior half of the perineum. The support of the latter was released by dividing the recto-urethral muscle just behind its attachment to the bulb. This served another purpose besides weakening perineal support, namely, enlarging the operative field by allowing the rectum to drop backward. The levatores were then divided, still more enlarging the operative field and facilitating exposure, and the prostatic sheath opened along the under surface of the prostate from apex to base. The sheath on each side was separated from the lateral and under surface of the retro-urethral prostate by the finger (as in prostatectomy). In two cases the bladder was opened above, only to experimentally confirm the extent of reduction of the neck and floor of the bladder, and in all three a Thompson searcher was introduced through the urethra for the same purpose. After freeing the sheath, the prostate was dislocated downward, very readily in one case but only slightly in the others, because of considerable size of the lateral lobes. In each case the reduction of the elevated neck of the bladder was very plain but insufficient. In each case sections were removed from the outer and lower portion of each lateral lobe. This resulted in still greater reduction, and, in one case where the enlargement was almost entirely of the middle lobe with marked upward projection of the bladder floor, the latter disappeared entirely. In each case the reduction seemed complete; the retroprostatic pouch was obliterated and good bladder drainage restored, except in one subject, where the pouch was large and trabeculated. In each case the urethra and bladder and ejaculatory ducts were uninjured, and enough of the prostate remained untouched to perform its functional purposes, in all probability. In each case the searcher indicated accurately the degree of reduction obtained. In each case the

steps were easily carried out; the operative damage was slight, —slight compared with prostatectomy with its unavoidable injury of the urethra,—and the resulting wound was superficial and capable of being made surgically clean. It was noted that even in moderate elevations it would undoubtedly be necessary to remove small sections of the lower prostate. That this method reduces vesico-urethral elevation effectively and by an operative procedure comparatively simple and harmless in character was confirmed by these experiments. Of its possibilities I was impressed at the time, and that it was a sufficiently safe and easy operation for general application.

I feel convinced that this method is appropriate in early cases of prostatic hypertrophy before the urinary tract has become infected and disorganized because it can be carried out as an aseptic operation with all that means; because the urinary organs are uninjured, and because the operative risk is seemingly small. Prostatectomy, on the other hand, fails as a justifiable measure in early cases for the reason that it is hazardous, needlessly opens the non-infected urinary tract, and requires drainage. In advanced cases with cystitis this method can be combined with perineal urethrotomy if desired. In aged and very advanced cases, where renal and other complications are present and a general anæsthetic contraindicated because of its superficial character, it might be executed under local infiltration anæsthesia. In cases where the degree of elevation varies, the extent of operative procedure can be gauged according to requirements. This method of reducing the vesico-urethral elevation in prostatic enlargement is yet purely a suggestion,—a suggestion based on analysis of the mechanical problem involved, and confirmed by anatomical experiment. Although untried clinically, it should accomplish reduction more satisfactorily than prostatectomy, the only method which successfully effects reduction. It is directly opposed to prostatectomy in that it attacks the inferior supporting structures, avoiding attack on the protruding prostatic mass above, while prostatectomy attacks this mass above, avoiding injury to the pelvic and perineal support below. While prostatic surgery has always

shunned injury to the pelvic floor, the harm of removing perineal support in the male is unknown, and is probably *nil*, because, unlike the female, there are no other important pelvic organs except the bladder to prolapse. Support of the bladder floor, following this method, would be maintained by the portion of the retro-urethral prostate remaining and the cicatrix filling in the perineal wound below. Prostatectomy, on the other hand, removes all support except the pelvic and perineal floor.

The conclusions which are to be drawn from the analysis of the problem in prostatic hypertrophy are:

(1) That it is not the prostate but the adjacent urinary tract which demands relief.

(2) That the direct cause of the interference with urinary evacuation is the displacement of the outlet and floor of the bladder resulting from enlargement of the retro-urethral portion of the prostate.

(3) That until the precise cause of prostatic overgrowth is known and successful preventive measures evolved, we can only hope to relieve this condition by correcting the displacement.

(4) That until an effectual method which is sufficiently safe and simple for application before infection and disorganization of the urinary tract has resulted, surgery cannot bring any great relief.

(5) That the logical mode of correcting vesico-urethral displacement is by reduction is evidenced by the fact that operative methods improve urinary evacuation by virtue of their power to reduce, more or less successfully, this displacement.

(6) That while some of these methods partially (sometimes completely) accomplish reduction with comparative safety, and others entirely reduce the displacement, but at considerable risk, none does so with both safety and success.

(7) That since the reduction of the vesico-urethral elevation is essentially a mechanic problem, reduction based on anatomic and mechanic principles should prove the simplest and safest method.

(8) That the method I have described is based on such reasoning and has received satisfactory confirmation through experimental work. That it will prove sufficiently safe and effective for general application, clinical results alone can show.

Ever since Morgagni discovered that the dysuria and urinary obstruction common in old men was due to an enlargement or hypertrophy of the prostate, surgery has attempted relief by removing in one way or another the "prostatic obstruction or obstacle" as the only curative or corrective measure. That hypertrophy is the cause of this form of dysuria is an established truth. That it is the indirect, and displacement of the urinary tract the direct, cause, examination of the bladder and urethra in these cases will prove. That reduction of the vesico-urethral elevation was the mode of relief and removal of the prostatic obstacle unnecessary to the "cure of obstruction," was demonstrated to me during a combined suprapubic and perineal prostatectomy. It was observed that, after the prostate was freed from its sheath and before it was removed, traction obliterated and corrected the bladder deformity. How to accomplish this without excision of the prostate and injury to the bladder led to a study of mechanics of displacement and anatomical experimentation as herein briefly put down.

ON THE TREATMENT OF FRACTURE OF THE MANDIBLE.

WITH METHOD OF WIRING.

BY STEWART LEROY McCURDY, M.D.,

OF PITTSBURG, PA.,

Professor of Orthopædic and Clinical Surgery, West Penn Medical College; Professor of Anatomy, Oral and General Surgery, Pittsburg Dental College; Orthopædic Surgeon, Presbyterian Hospital.

IT is not necessary here to do more than mention the various methods that have been recommended and used for the treatment of fracture of the mandible. They may have been efficient in the hands of their inventors, and have had and will have advocates and resuscitators throughout time. To say the most for them, they are in many instances failures, in others partially successful, while some methods are quite successful in selected cases.

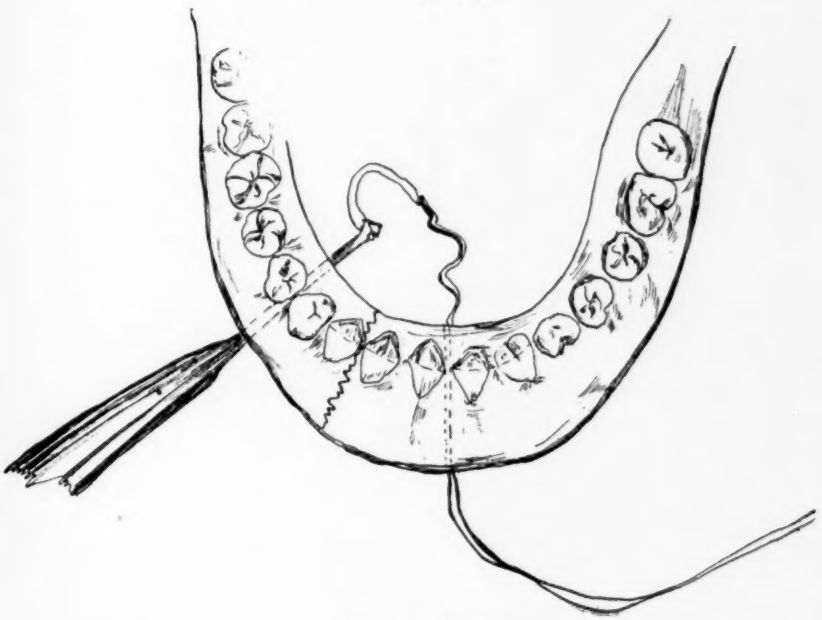
The Barton bandage as originally recommended, or as modified by Hamilton and Garretson, is pretentious, but does not hold fragments in position when there is a tendency to displacement. The interdental splint is a dental stunt, that makes a sewer of the mouth, a cavity for the culture of foul putrefactives, without furnishing any mechanical forces to hold the bones in position, but it rather by its interposition between the teeth tends to throw the fragments out of angle, and is not so good a splint as the upper teeth themselves. Wires about the teeth and the bands, screws, and bolts of Angle, and the wire splint of Weston & Kingsley are satisfactory in many instances; but all devices which have as their anchorage the normal teeth must necessarily be unstable when teeth do exist and impracticable when teeth are not conveniently located.

The treatment that will guarantee an adjustment of the fragments by a mechanism that maintains such adjustment throughout the period of repair is one that should recommend

itself to surgeons. The writer has operated on many cases, using a method of wiring similar to that practised in extremity surgery, with uniform success.

The method consists in drilling a hole through the mandible from the external surface of the bone into the sublingual cavity. The drill hole should be made between the apices of the second and third teeth from the lines of fracture, when this

FIG. 1.

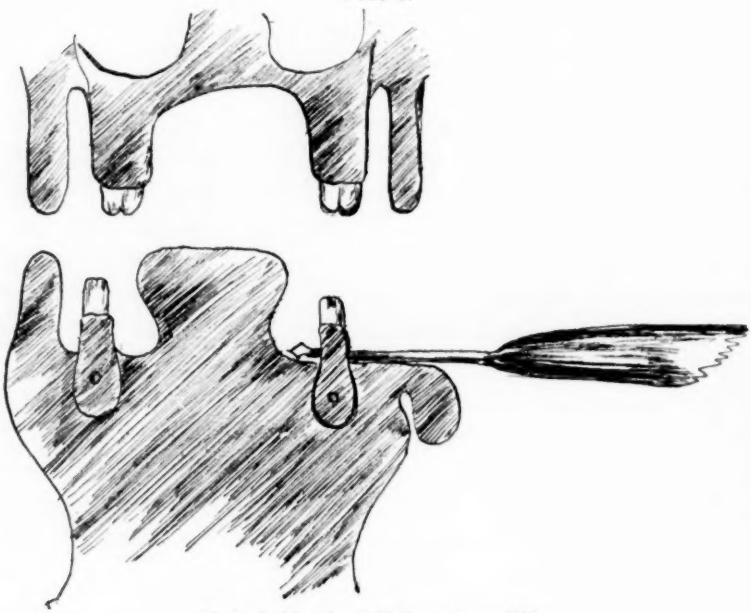


Wiring fractured mandible.

is possible, so as to guarantee firm anchorage for the wires. After the drill holes are made, they are threaded with a notched drill. The wire is now passed through from without into the mouth on one side, and with the thread through the drill hole on the other side it is drawn out (Figs. 1 and 2). The two ends of the wire are now drawn out firmly, and the loop on the inside of the bone is moulded to the surface of the mucous membrane. The free ends are twisted so as to bring the ends of the bones in perfect apposition. The wire is now

turned up along the remaining teeth, so that the sharp end may not irritate the mucous membrane of the lip. When one side has a tendency to drop, the drill holes should not be on the same plane; but, instead, the hole in the high fragment should be well up to the gingival margin, and the one in the lower fragment close to or below the dental canal. In some instances it will require but one hole, the teeth being used for anchorage. This is usually the case in fractures near the angle.

FIG. 2.



Method of passing drill through mandible.

The wires are permitted to remain in position for about six weeks, or longer if union has not taken place. They cause no irritation, sloughing of the gum or mucous membrane to speak of, as might be supposed; and if necrosis of the bone from pressure of the wire ever occurred in my cases, it was too insignificant to attract attention. Bandages and swaddling-cloths are not necessary. The patient soon learns to hold the teeth together. If infection occurs, an ice-cap should be applied directly to the face. Under this treatment suppuration seldom

occurs. The mouth should be cleansed with some strong antiseptic, as borolyptol, every hour or so. Before the adjustment of the fragments, the field should be thoroughly cleansed with 50 per cent. solution of alcohol. Iron wire is always used, since it is tougher, less irritating, and in every way superior to silver wire.

The method of feeding these patients is always a question of some concern. In cases where no teeth have been removed, it has been suggested that a tooth be extracted before adjustment of the teeth; but this has not been found necessary in a single instance. The method used has been to pass a curved glass tube back of the back teeth into the mouth; a fountain or other syringe can be used to force liquids into the oral cavity. In many cases the patient can suck the liquid from a glass with ease, provided the tube is made with sufficient curve to permit closure of the lips properly.

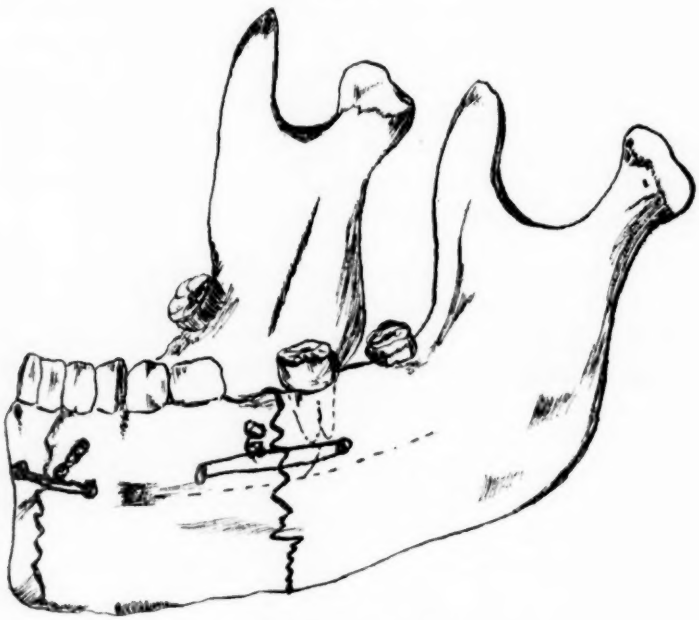
CASE I.—Fracture of the mandible through the last molar. There was a complete lateral displacement. The posterior fragment was resting on the outside of the body of the bone, and the ends of the bone were overlapping for some distance. The writer saw the case on the fifteenth day, and the soft tissues had repaired some, so that it was impossible to reduce the displacement through the mouth even under an anæsthetic. An incision was made parallel with the inferior margin of the mandible immediately over the fracture, the soft structures lifted from the bone so as to admit a strong bone elevator into the space in front of the anterior end of the posterior fragment. While the bones were pinched free from each other, great traction was made upon the mandible forward and inward pressure against the angle. In this manner the bones were reduced. Repair took place without a particle of deformity. Wiring in this case could not be done through the mouth in the usual way. A superficial wire was passed through the bones along the inferior border of the bone.

CASE II.—Patient sustained a fracture of the mandible by having a wheel pass over his face. The fracture was through the mental foramen on the left side. The case came to the writer fifteen days after the accident. There existed a dis-

charging sinus through the skin along the inferior margin of the bone. This case was wired according to the method above described. The bones were held in absolute position by the wires. The sinus closed, and at the end of six weeks the wire was removed, the patient having made a complete recovery without deformity or further necrosis.

CASE III.—Patient sustained a multiple fracture of mandible as a result of a fall from a bicycle. The first fracture was

FIG. 3.



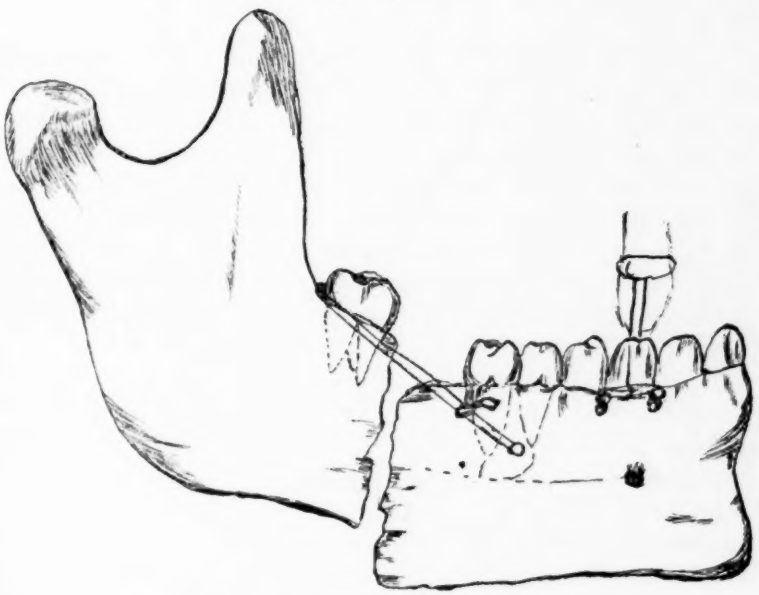
Multiple fractures of mandible.

slightly to the right of the symphysis, and the second was through the first bicuspid on the right side. At the time the case came to the writer, which was three weeks after the accident, there was extensive suppuration along the line of fracture, and a discharging sinus through the skin over the centre of the fragment. Wiring was done as shown in Fig. 3. After the removal of a couple of small fragments of dead bone the wound healed, perfect union occurred, and the patient was practically as good as before the accident. Wire was removed in seven weeks.

CASE IV.—Patient fell under wagon and wheel passed over face, fracturing jaw through symphysis. Case was seen on the twelfth day. Wiring was immediately done. There had been considerable infection, and a sinus existed through the skin slightly to the left of median line. During wiring the sinus curetted the ends of the fragments freshened. Union followed and articulation was practically perfect.

CASE V.—A Slav, referred to me by Dr. Kramer, of Uniontown, Pa., had sustained a fracture at a christening a few days before. The posterior fragment was tilted up by the masseter,

FIG. 4.



Showing method of obtaining upward and backward traction.

leaving a downward displacement of about half an inch. The object in wiring was to pull the anterior fragment upward against the posterior. Since the molar was perfectly solid, it served for an anchorage. The drill was passed through between the roots of the bicuspids. This furnished an upward and backward traction, and a perfect adjustment was not difficult (Fig. 4). Union followed, and the wire was removed in six weeks, with perfect articulation and no external deformity.

CASE VI.—Was kicked by a horse, resulting in the greatest displacement I have seen in any case. Wiring was done and a very satisfactory adjustment secured. Infection followed, resulting in great swelling of face and neck. Under ice-cap this was controlled. Repair was complete in six weeks, when the wire was removed. Articulation practically perfect.

CASE VII.—Fracture from fist blow in fight. Displacement was very slight and drilling of bone was not necessary. The teeth furnished sufficient anchorage, and union followed without complication.

CASES VIII and IX are similar to Case V. Were uneventful, repair occurring in both cases with practically no deformity.

CASE X.—Boy aged three years; was kicked in the face by a horse, resulting in fracture through the central part of the body of the mandible on the left side. A Barton bandage with an external vulcanite splint was adjusted by the family physician, and an interdental splint was made by a local dentist. These were ineffectually used for nine days, when the writer saw the case. After anæsthetizing the patient, a notch drill was passed through the bone in front of the second tooth anterior to the fracture, and the second hole back of the first tooth, from the outside, and the bones wired in the usual method. Union followed without complications.

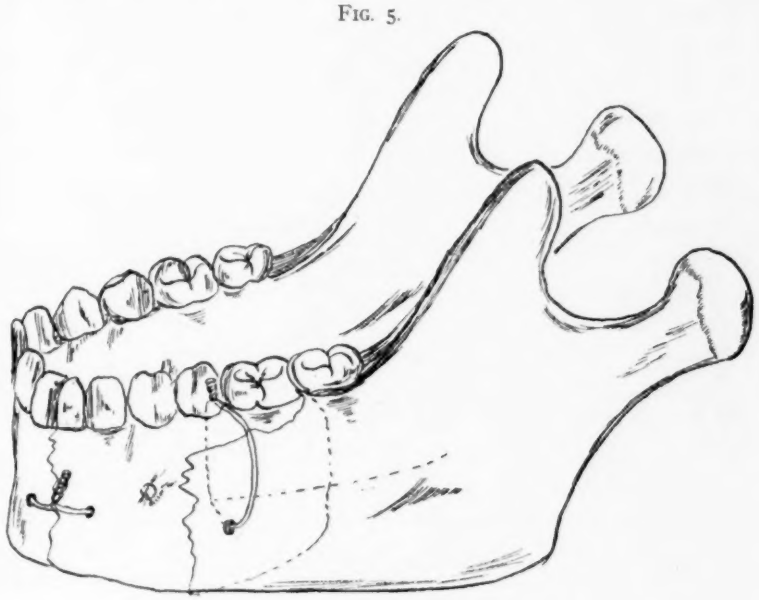
CASE XI.—Resulted from blow from a piece of steel. In this case the displacement was great, and the only way that the mandible could be held in place was by anchoring it to the upper teeth (Fig. 4). The drawing shows the fragments separated, so that the line of traction necessary to draw such displacement together might be seen. Repair followed. The teeth came together throughout after extraction of the molar in the posterior fragment.

CASES XII and XIII were uneventful, and repaired with functional usefulness.

CASE XIV.—Was that of a boy aged seventeen, whose face was caught by the drop shute of a coal-tipple, resulting in two fractures of the mandible; the first being through the angle on the left side, and the second passing obliquely across from without inward and forward, beginning at the first bicuspid and ending at the first incisor on the same side. This case was not seen until

the ninth day, after the ordinary mechanical methods had been used without success. Since the fracture was quite oblique, but one drill hole was made through the bone, and the wire brought up over the alveolus and twisted with sufficient force to hold the fragments in position. After wiring of the anterior fracture by the usual method, there was no tendency to displacements of the fragments at the posterior fracture, and repair took place with but slight deformity.

FIG. 5.



Ends of wire brought over alveolar process.

CASE XV.—Was an oblique fracture, including three teeth in the break; wiring consisted in passing the drill obliquely through the bone at the right angle to the line of fracture, but one hole being required. The ends of the wire were brought over the alveolar process and twisted on the outside of the teeth (Fig, 5). Union followed and no deformity resulted.

CASE XVI.—Was caused by falling upon the tip of the chin. Wiring was done as in the other cases, and union followed without deformity.

TRAUMATIC ANEURISM OF THE LEFT SUBCLAVIAN ARTERY PRODUCED BY FRACTURE OF THE CLAVICLE.

BY WILLIAM TAYLOR, M.B. (UNIV. DUBL.), F.R.C.S.I.,

OF DUBLIN,

Surgeon to and Lecturer on Clinical and Operative Surgery in the Meath Hospital and County Dublin Infirmary; Surgeon to Cork Street Hospital.

ANEURISM of the subclavian artery, from its comparative rarity, always possesses a certain degree of interest. When that aneurism is the result of a fracture of the clavicle it becomes at once a condition of exceeding rarity; consequently, this fact renders an apology from me, for bringing the notes of the following case and some remarks on the complications of fracture of the clavicle before the readers of this journal, quite unnecessary.

M. J., a pensioner, aged sixty-two years, was admitted into the Meath Hospital under my care on October 13, 1902. His history prior to September 28, that is, until a fortnight before admission, was that of a healthy man, his only sickness being a few attacks of malaria. There was no history of syphilis, and before his accident there had never been anything wrong with the arm or shoulder.

On the evening of September 28, when stepping off a dray, he slipped and fell outward on his left shoulder. The next day, notwithstanding the fact that his shoulder was swollen and paining him considerably, he went to his work, which consisted in wheeling gravel in a wheelbarrow, but on the second day, on account of the pain, he was unable to work, and came to the Meath Hospital, where the Resident Pupil on duty treated him in the ordinary way for a fractured collar-bone. The swelling was noticed, but thought to be the result of using his arm freely for almost forty-eight hours after fracturing the clavicle.

On October 13 I saw him, and feeling pulsation, which was indeed distinctly visible in the swelling, had him admitted at once into hospital. On examination the swelling was seen to

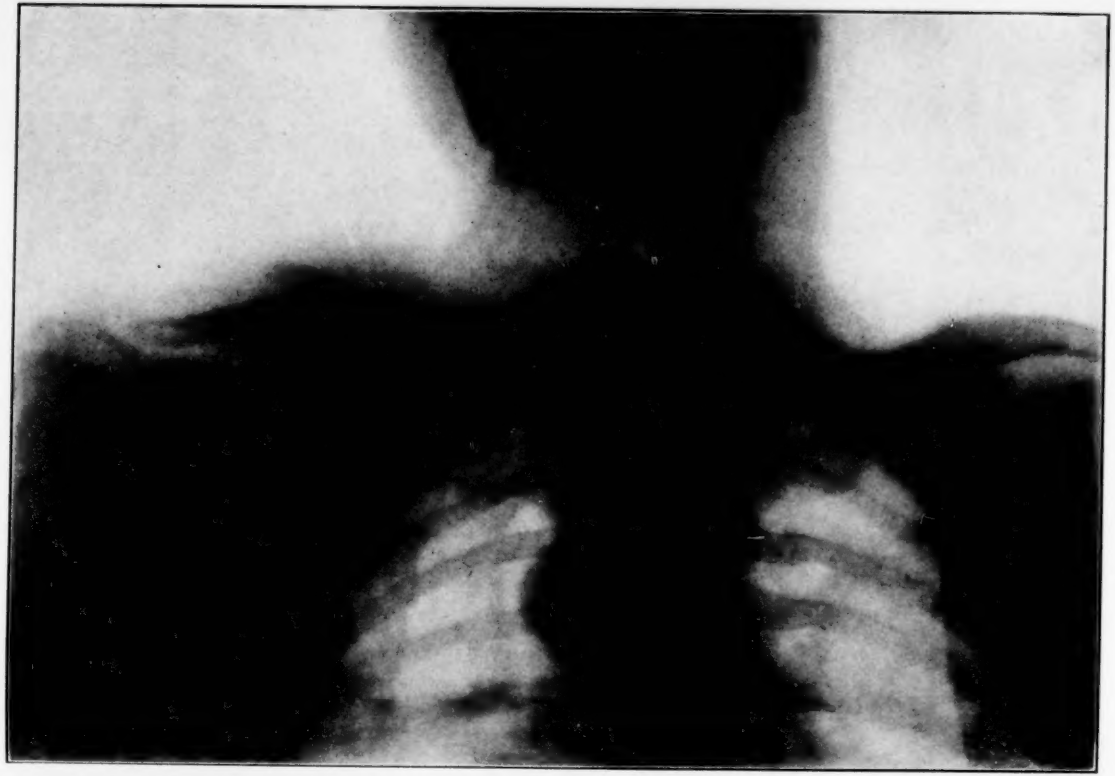


FIG. 1.—Fracture of clavicle; wound of subclavian artery by bony spicule; traumatic aneurism.

chiefly occupy the lower part of the left posterior triangle of the neck, but it extended forward underneath the sternomastoid muscle and downward below the clavicle, overlapping the broken fragments. It was most prominent just at the site of fracture, at which point the coverings were very thin and the pulsation more distinct. The tumor felt fairly hard all over, except just at its most prominent point, where it was soft and fluctuated distinctly. A loud bruit was easily heard all over it, and my medical colleagues were of the opinion that there was a diastolic aortic murmur. There were no evidences of any impediment to the venous return, but the patient complained of pain, tingling, and numbness down the arm and in the hand. There was no loss of power in the hand or forearm, The radial pulse on the affected side was much smaller than on the right side. There were some evidences of general atheroma, but the urine was free from albumen. My colleague, Mr. Lane Joynt, kindly took a skiagram for me (Fig. 1), which shows something of the outline of the tumor as well as the interesting condition of the broken fragments. A spiculum of bone is distinctly seen projecting downward at right angles from the inner end of the outer fragment. It was also noticed that the pulsation was not nearly so well marked in the sitting as in the recumbent position, while in the upright position it could not be detected at all, though the bruit could be heard in this position, but only faintly. The diagnosis was that of aneurism of the subclavian, produced by the spiculum of bone seen in the skiagram projecting towards the vessel.

The treatment for the next fortnight consisted in absolute rest, restricted diet, and iodide of potassium; but at the end of this time, as the aneurism was only increasing in size and threatening to rupture or suppurate (for the skin over its most prominent part and for some distance around had become red and œdematous), it was decided to endeavor to place a temporary ligature on the first stage of the subclavian, and then open the sac, turn out the clots, and deal directly with the site of the injury. To do this, an incision was made along the inner third of the clavicle as far as the sternoclavicular articulation; another incision was carried from this point upward along the inner border of the sternomastoid for about two and one-half inches, the flap thus marked out being reflected outward. With a wire saw the clavicle was divided about two inches from its inner end and the inner portion resected.

A very long, and I may say dangerous, dissection in a space full of important structures and considerably diminished by the encroachment of the now forcibly pulsating, thin-walled tumor, failed to distinctly expose the first stage of the artery. Wound of the vertebral vein, giving rise to alarming hæmorrhage for a moment or two, put an end to any further attempt to secure the artery in this stage. Gauze packing arrested the hæmorrhage from the vertebral vein. Three courses were now open to adoption. The first was to send the patient back to bed to die,—a course which certainly did not appeal to me. The second was to amputate at the shoulder-joint, and then follow up the axillary artery, and hope in this way to reach the site of injury; but I must say it did not seem to offer any bright prospect. The last was to open up the sac, turn out the clots, and make an attempt to secure the injured vessel. Before doing this, the portion of clavicle corresponding to the middle third of the bone was removed, so that direct proximal pressure might possibly be applied from without on the vessel while the clots were being turned out. The tumor was then freely incised and the clots turned out, The fingers being quickly pushed downward in the direction of the artery which was grasped by the thumb and index-finger, thus arresting the gush of blood until proximal pressure got the artery controlled. The space was then sponged clean of blood and clots, after which the artery could be easily seen lying at the bottom with a small opening in its upper and anterior aspect. The opening was of such a size as to admit a large-sized knitting-needle, and seemed to be about the middle of the third stage of the artery. There were no branches seen coming off this stage of the artery. An attempt to pass an aneurism needle round the vessel now showed the vein to be firmly adherent, and, as it was thought that any injury to the vein, necessitating its ligature also, in a patient so old and with diseased vessels, would in all probability demand amputation, a procedure which would likely be fatal, it was decided to apply forceps to the vessel. One forceps was applied external to the opening,—one over the site of the opening and one internal to it. Gauze was then passed into the space round the forceps so as to steady them. The inner part of the wound was closed with a small capillary drain in its inner angle. The shoulder and neck were enveloped in dressings and the patient put back to bed. The arm was supported on pillows

and wrapped up in warm wool. The operation lasted over two and one-quarter hours. The subsequent progress is easily told. The temperature never rose above the normal for over three weeks, when it ran up, due to an attack of malaria, but a few doses of quinine brought it down. The forceps were removed on the twelfth day, after which the wound rapidly granulated up.

The patient is now walking about quite well. I regret to say he has not yet recovered complete use of his arm, but this I attribute mainly to defective blood supply to his muscles on account of the diseased arteries. He never complained of any pain in the arm or hand subsequent to the operation, and from the time he recovered consciousness after the anæsthetic seemed to have complete sensation. Power is gradually returning, for he can now flex and extend his fingers and wrist as well as flex the forearm upon the arm.

With regard to complications attending fracture of the clavicle all authorities express but one opinion, viz., "That they are rarely, if ever, seen." It certainly seems strange that such an immunity should exist, when we reflect on the proximity of the subclavian artery and vein, the suprascapular artery, the apex of the lung, and the cords of the brachial plexus, and at the same time consider the amount of displacement of the fragments that we frequently see. So far as I have been able to learn from a perusal of the literature of this subject, any complications that have occasionally been observed have occurred chiefly in those cases in which the fracture was produced by direct violence, generally severe, such as the passage of the wheel of a cart over the shoulder, a railway smash, or due to lesions produced by a rifle-bullet. In these latter cases the complications have been attributed rather to the bullet than to the fragments of the broken bone. It has been furthermore observed that some of these cases, which were carefully examined post-mortem, had also a fracture of the first rib or upper three or four ribs, of which the first was one. The complications in these cases were mainly attributed to the fracture of the ribs and not to the fracture of the clavicle.

The neighboring nerves have been injured at the time of

the production of the fracture or have been subsequently implicated in the callus.

Stanley Boyd [1] makes the statement that several cases of injury to the brachial plexus have been recorded.

Jonathan Hutchinson, Sr.,[2] has noted hyperæmia and sometimes sweating of the same side of the head and neck, with a rise of temperature of 2° or 3° F.; injection of the conjunctiva and lachrymation; flattening of the cornea from diminished intraocular tension; contracted pupil and ptosis,—phenomena obviously associated with injury of the sympathetic nerve.

Gibson [3] reports a case of comminuted fracture in which the fragments were driven down behind the first rib, thus compressing the plexus and causing paralysis and atrophy of the whole limb.

Delens [4] records a case in which the superabundant callus of a fractured clavicle exerted such pressure on the subclavian vessels and nerves as to impair the nutrition and muscular power of the limb. (In this case two ribs were also broken.) Relief was afforded by resection.

Polaillon [5] mentions briefly a case of wound of one of the nerves of the brachial plexus due to a bullet which produced fracture of the clavicle about its centre.

Jobert [6] relates four cases of fracture of the clavicle due to bullet wounds. In one of these a paralysis of the arm due to a lesion of the nerves of the brachial plexus was noticed. Two were uncomplicated; the other will be mentioned later under "injuries to vessels."

Stimson [7] says, "In a few reported cases symptoms indicating injury to the brachial plexus have appeared immediately or after an interval, and among four other cases mentions one of his own reported in the *New York Medical Journal* for June 11, 1887, in which extensive motor and sensory paralysis of the limb existed from the first, although there was no recognizable displacement.

Other cases are reported by Hassler,[8] Davis,[9] Mauclaire,[10] and Poirier.[11]

Hassler [8] obtained complete relief for his patient by resection of the callus.

Davis [9] cured his patient by correcting the displacement by operation.

Mauclaire [10] brought about recovery by removing a splinter of bone three weeks after the injury.

Poirier [11] was compelled to amputate on account of the intolerable pain in the paralyzed limb. The fracture in Poirier's case was a comminuted one and due to direct violence.

As regards injuries to the vessels, Mr. Christopher Heath [12] —whom I must here thank for sending me a report of his case of aneurism of the subclavian artery—details a case in which a patient was admitted under his care into University College Hospital in September, 1878, with a comminuted fracture of the left clavicle, and a simple fracture of the six upper ribs on the same side, the result of being run over by a van.

On admission, the radial pulse on the injured side was normal. He was then detained for fifteen days, during which severe bronchitis supervened. Subsequent to his discharge, he attended regularly as an out-patient, but it was not until a month after his discharge that any undue pulsation was noticed. At this time he was readmitted with a pulsating tumor occupying the lower part of the left posterior triangle of the neck and extending beneath the clavicle for a short distance. Distinct pulsation was felt over the clavicle, and a double bruit was heard, the systolic being the louder. The left radial pulse was much smaller than the right. There was some œdema of the left arm. There was no pain in the tumor, nor shooting sensations down the arm, but the arm was almost completely paralyzed. On account of the rapid increase in size of the tumor, rupture of the sac appearing likely, and the useless condition of the arm from paralysis, Mr. Heath was led to perform amputation on November 4. The wound seemed to run a favorable course, but the aneurism continued to increase until, on January 1, he introduced needles into the sac, which seemed to have the effect of leading to some consolidation in the contents. Death, however, took place on January 18, apparently from congestion of the lungs.

The autopsy showed a comminuted fracture of the clavicle about three and one-half inches from its sternal end, *i.e.*, a little to the outer side of its centre, the innermost fragment overlapping the external for quite an inch.

The fracture was firmly united, and at the lower margin, close to the communication between the artery and sac, a spiculum of bone projected. The sac of the aneurism was closely

adherent to the clavicle at the seat of fracture. The first rib was fractured close to the subclavian groove, the fracture being comminuted. The aperture of communication of the artery with the aneurism was about one and one-half inches from the thyroid axis, and measured about one-third of an inch, and was situated on the upper and anterior part of the vessel. The suprascapular artery could not be found. The subclavian vein was adherent to the sac and impervious beyond the clavicle.

Mr. Heath in his remarks said that it was impossible that the artery could have been punctured by the comminuted clavicle, for no immediate symptoms were observed; but it seemed probable that the vessel might have been bruised or stretched by the broken first rib, and that a diseased spot in its coats might have yielded. (There was a history of syphilis.)

The aneurism was distinctly sacculated, which pointed to its traumatic origin, for spontaneous aneurisms of the subclavian are more generally fusiform.

Mr. Anthony Bowlby[13] has reported an extremely interesting case of injury to the subclavian artery produced by a fractured clavicle. It is that of a woman aged sixty years, who was knocked down and run over in the street, sustaining thereby a fracture of several ribs as well as a fracture of the right clavicle. On admission into St. Bartholomew's Hospital, it was noticed that in addition to the injuries already mentioned the whole of the right upper extremity was cold, white, and pulseless. This condition continued until death, which took place the next day, with the exception that the limb became warmer. There was at no time threatening of gangrene.

The autopsy showed that the right clavicle was fractured in its middle, and the first rib on the same side was broken close to its cartilage. The second part of the right subclavian artery for a distance of an inch or more was soft and flattened. On opening it, it was found that the arterial walls were healthy, and that the softened part of the artery was blocked by clot. When this was washed out, it was found that the lumen of the artery was completely occluded on the distal side of the softened area by the torn middle and internal coats, and further examination showed the following conditions: At the junction of the first and second portions of the subclavian the internal and middle coats had been cleanly divided, as if by a narrow ligature, at

right angles to the long axis of the vessels. At the cardiac side of this injury the coats had not retracted at all, nor had they curled in towards the lumen of the vessel. On the distal side, however, the inner and middle coats had been entirely stripped from the outer for a distance of more than an inch, and had been completely invaginated and thrust as a plug into the lumen of the artery beyond, so that the third part of the subclavian was plugged by the torn coats which ought to have lined the second part of the vessel, and on the rough inner surface of the second portion of the artery the blood had subsequently clotted.

Mr. Bowlby's opinion was that the artery must have been nipped up by the ends of the broken clavicle, which, being driven inward and backward, had been thrust with great violence into the vessel, in spite of the protection afforded by the scalenus anticus. He also concluded that after the division of the inner and middle coats the blood stream had made its way between the middle and external coats, and, having stripped up the former, had thrust it, together with the inner coat, into the lumen of the vessel beyond, and had thus prevented the further passage of blood along the damaged trunk.

Evans [14] reports a case in which an aneurism of the innominate artery was ascribed by him to a fracture of the right clavicle sustained by a patient, a sailor, many months before he came under surgical observation. The fracture was situated two inches from the sternum. Post-mortem showed inner fragment completely absorbed and sternum eroded. The probabilities are that the aneurism preceded the fracture, and may indeed have predisposed to it.

Twyman [15] details a peculiar case, which was that of a girl of eighteen years, who in falling off her horse struck the stump of a tree, fracturing the right clavicle at the junction of the outer and middle third. An aneurism formed, supposed to be due to the penetration of the artery by a sharp spiculum of bone. When first seen, the swelling was about half the size of a walnut and just over the artery. On admission subsequently into hospital the swelling extended for a distance of three and one-half inches, from the sternoclavicular articulation, partly overlapping the inner fragment, to a point one and one-half inches from the tip of the acromion. Upward it reached as high as the fourth cervical vertebra at a point midway between the spine and trachea.

Inward it reached sufficiently far to press upon the carotid vessels. Operation thirty-one days after the accident. The innominate was easily ligatured, being well pulled up by the tumor. The carotid was also ligatured one inch above its origin. In eighteen hours coma and death. The post-mortem showed wound of the first part of the subclavian at about one-sixth of an inch external and distal to the origin of the thyroid axis and vertebral arteries. The phrenic nerve was involved in the greatly condensed and thickened fibrous tissue forming the sac.

Ayres,[16] a surgeon in the United States Volunteers during the War of the Rebellion, reports the case of a scout who was shot, the ball striking the external third of the clavicle and fracturing it. The bullet passed obliquely inward and backward and emerged behind near the spinal column, having opened the right pleural cavity. A month subsequently, a severe hæmorrhage from the subclavian artery occurred, and the vessel was promptly tied in the first part of its course. The hæmorrhage ceased immediately when the ligature was drawn, but the patient sank and died in half an hour. The post-mortem showed that the bullet had fractured the clavicle in its outer third and the first rib. It then opened the pleural cavity in its course, and made its exit on the left side of the spinal column, fracturing the spines of the seventh and eighth cervical vertebræ. The hæmorrhage from the subclavian was due to a sharp spiculum of bone which had caused ulceration of the coats of the artery.

Souchon,[17] of New Orleans, in an exhaustive paper on "Operative Treatment of Aneurisms of the Third Portion of the Subclavian Artery," details fifteen cases of traumatic aneurism of which twelve ended fatally and three recovered. Only one of the fifteen was stated as being due to a fractured clavicle. It was that of Twyman, already referred to by me.

The subclavian vein is said to have been more frequently injured than the artery, but the following are the only cases of injury to the big vein trunks that I can find.

Most of us have heard of the late Sir Robert Peel dying from injury to the subclavian vein. The case will be found reported in the *Lancet*[18] of July 6, 1850. There was a comminuted fracture of the left clavicle, below which a swelling as large as the

hand could cover was found. This swelling pulsated synchronously with the contractions of the auricles of the heart. The condition was described as a "diffuse false venous aneurism." One or two of the ribs of the left side were also fractured. The late Sir John Erichsen,[19] then Mr. Erichsen, delivered a clinical lecture at the University College Hospital, London, on a case of "comminuted fracture of the clavicle, with compression of the subclavian vein by one of the fragments." The fracture was due to direct violence. Gangrene of the arm subsequently supervening necessitated amputation at the shoulder-joint. Death from pyæmia ended the scene. In that lecture Mr. Erichsen said, "The artery appears always to escape. I know of no case in which it has suffered if gunshot wounds be excluded." In the editions of his treatise on "Surgery," published subsequent to the delivery of this lecture, mention is made of the cases of Heath and Bowlby already detailed by me.

Manoury [20] records an instance of injury to the subclavian vein. In this case the extravasation extended from the cheek to the fingers, with slight pulsation and systolic bruit in the supraclavicular region. The limb became paralyzed, and the radial pulse was lost, but reappeared on the second day. Manoury had to incise above the clavicle, but the patient died immediately from the entrance of air into the subclavian vein, which was almost torn across.

Bonne [21] reports a case in which a fragment from a comminuted fracture of the clavicle produced somewhat serious symptoms by pressure upon the subclavian vein and adjacent nerves.

Jobert [22] relates a case in which the internal jugular vein was wounded by a fractured clavicle produced by a bullet. The patient succumbed in about twenty-four hours.

Ogle [23] reported a case in which the internal jugular vein was wounded, the specimen being in St. George's Hospital Museum. This case was that of a youth of twenty-three years of age, who, while standing under a tree during a thunder-storm, was struck by a falling branch and died immediately. The post-mortem demonstrated the nature of the lesion to have been a tear in the right internal jugular vein, a quarter of an inch above its junction with the subclavian to form the innominate. The opening would have admitted an ordinary pea.

Polaillon [24] said "wounds of the pleura and lung are not so

rare as wounds of the vessels," and said he knew of three examples. They were those of Vigarous, Velpeau, and Huguier.

Vigarous [25] was compelled to make incisions in order to relieve the embarrassment to respiration and save his patient from death. The case was that of a carrier who had his left clavicle broken by the shaft of his cart, the fracture being an oblique one. The patient in an instant felt his chest, neck, and head become rapidly inflated; his eyes became closed up, and in a short time his head, neck, chest, and trunk are said to have acquired two and a half times their normal size.

After examining the patient to discover the cause of the emphysema, Vigarous then reduced the fracture and immobilized the broken fragments, but as the emphysema instead of diminishing only went from bad to worse, a large incision was made at the bottom of the neck. In three or four days the head, neck, and upper part of the chest had almost returned to their natural state, and at the end of eight days the emphysema had entirely disappeared.

In the cases of Velpeau [26] and Huguier [27] great care was taken by these surgeons to be quite certain that there was no rib fractured, and that the infiltration of the cellular tissue with air was the result only of a wound of the lung produced by a fragment of the broken clavicle.

Gibier [28] reports a case in which the acromial fragment wounded the lung and produced emphysema. The patient recovered, but with non-union of the fracture.

Mercier [29] relates a similar case.

The only difficulty seems to be that of excluding fracture of one or more ribs which might have been the cause of the injury to the lung. In most of the cases referred to above the surgeons were not unmindful of this difficulty and seemed to have endeavored to exclude it.

While my communication up to this has been devoted entirely to complications of a serious nature produced by fracture of the clavicle, I might now, by way of contrast, be permitted to mention the following curious and remarkable case in which fracture of the clavicle was supposed, in some mysterious way, to have cured a pre-existing aneurism of the subclavian artery.

Harte,[80] who reports the case, gives the history as follows: "The patient about a year ago noticed at the root of his neck a large swelling which pulsated and was of considerable size. He did not seek any medical advice for this. While descending a flight of stairs he tripped and fell, striking his shoulder and fracturing his clavicle. When admitted into hospital, a large pulsating expansile mass was seen, corresponding to the position of the subclavian artery, while directly over that, and lost to a certain extent in the surrounding swelling, were the two ends of a fractured clavicle. On auscultation all the physical signs of an aneurism were evident. Shortly after admission there was considerable ecchymosis around the seat of injury, and the pulsation and bruit, with a well-marked radial pulse, still continued. Four days after the receipt of the injury, attention was called to the fact that the pulsation had entirely ceased in the region of the injury. That a clot had formed was also evident from the increased density of the tumor. No attempt was made to correct the deformity in the clavicle. The only treatment consisted in rest on his back in bed with a small sand-bag resting on his shoulder. All evidences of pulsation completely disappeared, leaving only a clavicle united with some deformity."

Dupuytren[81] is quoted by Stimson, Hamilton, and several others as having said he saw two or three cases of aneurism of the subclavian artery the result of a fracture of the clavicle; but on carefully reading over his lecture on aneurism I failed to see where any such mention was made, and certainly no case was described by him in any of his lectures published in book form either in the original or in the English translation.

There is a case reported by Jacquemier[82] in which an aneurism of the acromial branch of the acromiothoracic artery followed a fracture of the clavicle produced by direct violence.

It will thus be seen that, in my perusal of the literature of this subject in both French and English, I have only been able to discover the following as complications of a fractured clavicle:

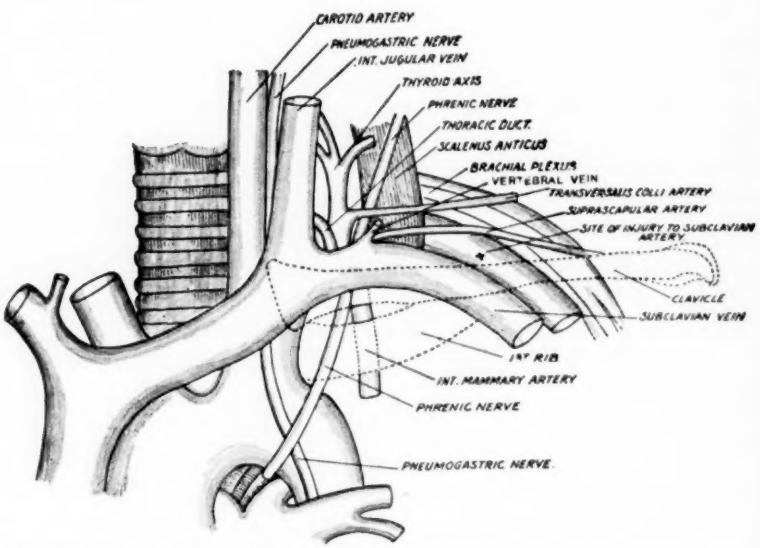
Ten authentic cases of injury (immediate or remote) to the neighboring nerves.

Four authentic cases of wounds of the subclavian artery. My own case makes the fifth.

Here I would point out that the others arose in connection with fractures produced by direct violence and all terminated fatally, whereas mine arose from a fracture produced by indirect violence and has fortunately ended in recovery.

One case of alleged injury to the innominate artery leading to the development of an innominate aneurism. It is more than probable that the aneurism existed prior to, and possibly may have predisposed to the production of, the fracture.

FIG. 2.



Drawing done by my clinical clerk, Mr. A. N. Crawford, from a dissection made by Professor Fraser, Professor of Anatomy, Royal College of Surgeons, Ireland.

Four cases of injury to the subclavian vein.

Two cases of injury to the internal jugular vein.

One case of aneurism of the acromial branch of the acromiothoracic axis of arteries and five cases of wound of the lung associated with emphysema.

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REPORT OF A CASE OF RECURRENT DISLOCATION OF THE ULNAR NERVE CURED BY OPERATION.

WITH SUMMARY OF PREVIOUSLY REPORTED CASES.

BY FARRAR COBB, M.D.,

OF BOSTON, MASS.,

Surgeon to Out-Patients at the Massachusetts General Hospital; Assistant in Clinical and Operative Surgery at Harvard University.

THE rarity of this kind of operation and the very successful result in the following case have seemed to the writer to justify this report and analysis.

Recurrent dislocation of the ulnar nerve at the elbow may occur (1) from non-traumatic causes, the so-called "habitual," "congenital," or idiopathic cases; (2) from trauma. The cases of "habitual" dislocation are much more numerous, but in these cases the symptoms are rarely severe enough to need operation and, as a rule, yield to simple palliative treatment. Traumatism has furnished all the cases which have been operated upon, with two exceptions,—the cases of Sir William MacCormac and Damas, summarized later in this article.

Abnormal mobility of the ulnar nerve is not uncommon, and may be present to the extent of complete luxation forward of the internal condyle without causing any symptoms, and even without the knowledge of the individual. Collinet found that in 500 persons, the nerve slipped completely forward on flexion of the forearm in thirteen, and in five of these the dislocation involved both nerves (right and left). Drouard found complete luxation in three out of 200 patients. The majority of these persons had no symptoms. The writer, in a series of 150 large and well-developed men, found only one case of complete dislocation forward of the condyle, and this caused no symptoms. In over one-third of the cases, the nerve, on flexion of the forearm, slipped or was pushed by the triceps

muscle nearly or quite to the tip of the internal epicondyle, but not over it or forward. The writer has seen characteristic disabling pain down the nerve into the fingers on flexion of the forearm in only one case, where no increased mobility of the nerve could be found. This was the case of a tinsmith who had been disabled for six months. Flexion of the forearm caused pain at the inner side of the elbow and into the inner fingers of the hand, but in his case no luxation or abnormal slipping of the nerve could be made out. Rest upon the splint caused his painful symptoms to disappear. It is the accepted theory of nearly all of the men who have reported cases of this condition that the darting pain along the course of the nerve is caused by the trauma of the oft-recurring excursions or jumps over the condyle, and that in a comparatively short period of time pathological changes in the nerve and its sheath take place. In most of the cases operated upon the nerve was found to be distinctly enlarged and fusiform in shape. The only case in which a microscopic examination of the nerve structure has been made was in the case of Andrae, which is summarized among the cases given below. Acting on the theory that the dislocation was due to excessive length of the nerve caused by stretching, Andrae excised the fusiform enlargement and sutured the ends of the resected nerve together. Examination of this excised piece showed a typical neurofibroma with marked thickening of the nerve sheath.

The whole subject of luxation of the ulnar nerve has been treated by Poncet, Momburg, Schwartz, Annequin, and Jopson of Philadelphia, and by Cotton of Boston. If a complete review of the question is desired, the papers of these surgeons must be consulted. The practical conclusion from all their research is that idiopathic dislocation is not uncommon, but, as a rule, the symptoms are not serious enough to demand operation.

It is the purpose of this paper to report a traumatic case operated upon by the writer and to summarize all other reported cases of operation, only fifteen in number. So far as known, no complete collection of these operations has been made.

The report of the writer's case is as follows:

J. W., single, aged fifty-two years, a lumberman by occupation, was seen first at the Massachusetts General Hospital in September, 1900. His family history was unimportant, likewise his personal history previous to this disability. Two years before, he struck the inner side of the left elbow violently against a post while trying to save himself from a fall. At that time the elbow was swollen and tender, and motion of the forearm caused pain in the region of the joint, but he had no recollection of painful or tingling sensations in the hand immediately following the injury. The elbow was bandaged by his family physician, who told him that no bones were broken. In ten days or two weeks the swelling and tenderness had disappeared, and the elbow gave him little trouble until a month later, when the present disabling pains began. This pain has constantly increased, and at times has been very severe over the inside of the elbow and down the inner side of the forearm into the two inner fingers of the hand. Numbness in these fingers has been present constantly for the past year. Over twelve months ago he began to notice that flexion of the forearm caused these pains and tingling sensations, and that there was a "round cord" at the inner side of his elbow that slipped forward and back, and when he struck this or pressed upon it he started up the familiar darting pains. For six months he has been disabled for any kind of work, and has kept from moving his forearm as much as possible. The patient was a man of moderate muscular development, whose general physical condition was sound in every respect. Examination of the left arm showed the bones normal in size and position, and all the motions of the elbow-joint entirely free; no evidence of old fracture was present. Flexion and extension of the forearm caused pain referred to the internal condyle of the humerus, the inner side of the forearm, and the two inner fingers of the hand. The ulnar nerve could be felt under the skin, and, comparing it with the right ulnar nerve, which was presumably normal in size, appeared to be twice as large. In extension of the forearm the enlarged nerve could be felt back of the internal condyle, but apparently more superficial than on the right side; but on flexion of the forearm past a right angle the nerve could be felt to roll over the tip of the internal condyle, until on complete flexion it was dis-

tinctly felt well in front of the condyle. This rolling forward of the nerve always caused the pain in the fingers and at the elbow. The enlarged nerve could be held in position behind the condyle during the flexion of the forearm by pressure with the fingers. Pressure on the nerve or rolling it with the fingers caused the patient much pain, not only at the elbow, but also throughout distribution in the hand. There was no loss of sensation in the region supplied by the ulnar nerve. The strength of the hand was good and there was no apparent muscular atrophy. He was advised to try palliative treatment for a few weeks, and if this proved of no avail to submit to an operation. Accordingly, the arm was put at rest on an internal right-angled tin splint with a pad holding the nerve firmly in place. While this splint was worn he was free from pain, but on removing it at the end of three weeks the recurrent luxation of the nerve with the accompanying pain at once reappeared. Upon this he was admitted to the hospital on the service of Dr. H. H. A. Beach, through whose courtesy the writer, his assistant surgeon, was permitted to operate.

Operation.—Under ether anæsthesia, with the forearm slightly flexed, a somewhat curved incision three and a half inches long was made midway between the olecranon and the tip of the internal condyle. As the skin was dissected back, it became apparent that the enlarged nerve was very superficial, and the bony groove at the back of the internal condyle, in which normally the nerve should rest, was filled by muscle-fibres, evidently a portion of the triceps. The nerve was covered by a loose and thin investment of fibrous tissue, and could be easily moved about between the points where it emerged from the intermuscular septum and passed through the two heads of the flexor carpi ulnaris muscle. For the distance between these two fixed points the nerve was fusiform in shape and as large as a lead-pencil in the thickest portion. There was no strong bridge of fascia, the so-called arcuate ligament, passing over the nerve; and it was manifest that at the original injury the fibrous and muscular structures back of the internal condyle had been torn or ruptured, and that not only had the tearing of the tissues allowed subsequent freedom of motion to the nerve to the extent of dislocation forward, but that in the process of repair the bony groove previously and normally occupied by the nerve had become completely filled up by some fibres of the triceps muscle. These were dissected

up from their abnormal insertion, and after the nerve had been placed in its groove these fibres and a portion of the fascia of the triceps were carefully sutured with catgut to the fascia covering the flexor carpi ulnaris, thus making a roof over the nerve and its canal. The wound in the skin was sutured with fine silkworm-gut stitches without drainage, and a sterile gauze dressing applied, after which the arm was put up in extension on a straight internal splint. Healing by first intention was obtained. At no time after the operation was there complaint of pain. At the end of two weeks the straight splint was removed and a right-angled splint substituted for one week. At the end of four weeks all bandages were removed and the man was allowed to use the arm. The nerve could no longer be felt; there was none of the old pain on flexion nor any tenderness on pressure. At the present time, two years and a half since the operation, the patient reports that he has been able to use his arm in all ways, and regards himself as absolutely cured.

Summary of previously reported Cases.—The following cases, fifteen in number, are given in chronological order. It will be noticed that the earliest reported operation was done as recently as 1888.

CASE I.—PONCET (*La Semaine Médicale*, 1888, p. 93). Child, fifteen years old, at the age of ten years fell from a horse, receiving an injury to the right elbow which necessitated rest on a splint for five days. This injury caused no lasting disability. Five years after, when violently throwing snowballs, had sudden and severe darting pain into the two inner fingers of the right hand. Could not rest the elbow on the table, as in writing, without causing this pain. No mention of pain at the elbow. Examination showed evidence of an old fracture with shortening of the internal condyle; no internal epicondyle could be felt. Palpation of the nerve caused painful sensations in the fingers.

Operation.—Kind of incision not mentioned, nor the size and shape of nerve or condition of the tissues in the region of the condyle. A new canal for the nerve was made by dissecting up fibroperiosteal flaps from the back of the deformed condyle, and stitching them to the nerve with three catgut sutures, after which the nerve was covered by flaps of fascia. Kind of fixative dressing after operation not given. Since operation, nerve has remained in place with no return of symptoms.

CASE II.—ANDRAE. (In nearly all the previous articles this man's name has been spelled Andral; it is correct as here given, George Andrae.) "Über traumatische Luxation des Nervus Ulnaris am Ellbogen," Inaugural Dissertation, Greifswald, December 21, 1889.

Muscular man, struck by a piece of wood over inner side of right elbow; much swelling, discoloration, and pain, with loss of sensation in the ulnar distribution in the hand, and loss of motion in the little finger. A small fragment of bone was broken off the tip of the internal epicondyle. Plaster-of-Paris bandage for four weeks. Examination three months after the injury found inability to work because of weakness in the hand and pain in the fingers; the nerve was spindle-shaped and hard and dislocated forward on flexing the forearm, but could be pushed back into its groove and held there; there was a small amount of atrophy of the forearm, and especially in the interossei of the third and fourth spaces in the hand. Sensation was evidently weakened. Andrae thought the disturbances of motion and sensation could not be cured by restoring and fixing the nerve to its normal position, and also that the dislocation was caused by the nerve being too long. He therefore, four months after the injury, resected the fusiform enlargement without attempting to fix the nerve in place. Microscopic examination of excised piece showed typical neurofibroma. One month after the operation a spindle-shaped enlargement was again felt, and dislocation still occurred. Four months after patient was much worse than before the operation, with increasing atrophy, pain, and loss of sensation.

Case III.—Annequin ("Archives de Médecin et de Pharmacie Militaires," Paris, 1890, Tome xv, p. 432). A soldier fell in the gymnasium, striking violently on the internal aspect of the left elbow. Immediately he noticed severe shooting pains in the last two fingers, followed rapidly by loss of sensation and motion. These symptoms persisted until entering the hospital, nine days after the injury. A general swelling, without hæmatoma at the elbow, was said to have existed previous to entrance. Examination showed almost complete loss of motion and sensation in that part of the hand supplied by the ulnar nerve, but no atrophy or vasomotor disturbance. The nerve was felt just under the skin, and was evidently enlarged; in flexion of the forearm it rolled well to the front of the internal condyle, and even in extension did not go farther back than the tip of the epicondyle. Flexion of the forearm or pressure on the nerve caused pains into the fingers. No evidence of fracture found. An internal right-angled splint with a pad over the nerve worn for twenty-seven days; while wearing this, sensation and motion returned to the fingers. On the removal of the splint, dislocation of the nerve immediately recurred and all the disabling symptoms. Operation thirty-nine days after the injury. Incision slightly curved, midway between the olecranon and internal epicondyle. The strong fibrous arch (the arcuate ligament) which normally crosses the nerve was wanting. An exceptionally low and strong insertion of the triceps muscle to the inner border of the olecranon was found (no insertion of muscle into the groove back of the condyle, however); because the operator thought these muscle-fibres would not unite well to the aponeurotic flap he excised them, *i.e.*, where they ran down on the olecranon. He concluded, however, that this was a mistake, and that this part of the triceps should have been used as a flap to cover the nerve, as was done in the writer's case. The nerve

was replaced and covered with flaps of fascia; the internal flap from the internal lateral ligament and periosteum, the external from the fascia of the triceps, "especially" from the triceps tendon; these flaps were sutured over the nerve with catgut. The external wound was closed without drainage, and an internal right-angled splint applied and left on for three weeks. For some days after removing the splint, flexion caused sharp pain at the elbow, but at the end of the fifth week this had disappeared. Ultimate result was entirely successful. Appearance and size of the nerve not remarked upon at operation.

CASE IV.—G. MUNRO SMITH (*British Medical Journal*, February 11, 1893). Very brief report of this case obtainable. A man fell, striking elbow; no fracture. Nerve felt in front of the epicondyle, but could be reduced easily. No account of symptoms given, but the inference is that pain was present. Attempts to keep the nerve in place by pads, etc., for six weeks failed. Seven weeks after the injury nerve fastened in place with catgut sutures. Built a bridge behind nerve by uniting the triceps tendon and the firm connective tissue about the internal condyle. Result said to have been good.

CASE V.—SIR WILLIAM MACCORMAC (London *Lancet*, 1891, p. 1041; *Transactions of American Surgical Association*, 1895, Vol. xiii, p. 375). Man, aged thirty years; clerk by occupation; previous occupation and heredity unimportant. Two years preceding 1891, without trauma or any known cause, first noticed a painful weakness in his right arm, which soon became serious enough to prevent his writing steadily. Examination at the end of the second year found a man in good general health complaining of much pain shooting down into the ring and little fingers of the hand, especially when resting the elbow on the table in writing, with the pain a constant sense of fatigue in the hand and forearm. No anæsthesia, no paralysis or atrophy evident. On flexing the forearm the ulnar nerve was found to dislocate quite forward of the internal epicondyle. The patient had noticed the loose nerve himself.

Operation.—Two years after the first symptoms. A longitudinal incision midway between the olecranon and tip of internal condyle two inches long. The nerve had a "thickened sheath." Two kangaroo tendon loops were passed around the nerve, one inch apart, and fastened to the fascia over the triceps, and the fascia was then sutured over the nerve (how is not stated). External wound closed without drainage, and a plaster-of-Paris bandage applied (position of arm not stated, nor length of time splint was left on). Result was a complete cure. Nerve has remained in place.

(This case and the one following have been referred to as cases of E. C. Stabb. They were first reported by him, London *Lancet*, 1897, Vol. i, p. 1040.)

CASE VI.—MR. CROFT (London *Lancet*, 1891, p. 1040; *Transactions of American Surgical Association*, 1895, Vol. xiii, p. 377). Woman, twenty-eight years old, fell, striking her elbow. Septic infection followed, starting as a bursitis. Two incisions were made, but not in the region of the ulnar nerve. The suppuration ("cellulitis") was entirely superficial,

and had subsided in one week. There was no fracture. A few days after noted tingling pain from elbow into two inner fingers, which pain was aggravated by flexion, and was associated with a feeling of numbness and sensation of something slipping at the under side of the elbow. Examination two months after the injury found nerve dislocated on flexion, no paralysis of motion or sensation, no atrophy.

Operation.—Semilunar incision; nerve had a "thickened sheath" and was readily movable; it was stitched to the anterior surface of the triceps, and then the inner border of the triceps was sutured to the fascia over the flexor group of muscles. Silk was the material used. Wound closed without drainage, and a plaster-of-Paris bandage with the arm in extension (time of wearing this not given). For two days after the operation slight dulness of sensation and pricking in the little finger. Result was successful. Nerve remained in place.

CASE VII.—M. SCHWARTZ (*Bulletin et Mémoires de la Société de Chirurgie de Paris,* Tome xxii, 1896, p. 202). In October, 1895, a man, eighteen years of age, caught the right upper extremity in a machine while it was in motion, so that, while his forearm was flexed at an angle of ninety degrees, the elbow was grasped so firmly as to tear the skin for some distance from the anterior surface. Immediately after this he felt sharp pains dart into the two inner fingers of the hand. No paralysis of sensation or motion noticed; much swelling of the elbow followed. The wound in the skin was dressed antiseptically and healed kindly. Within two weeks after the accident, splints and bandages were removed and he returned to work; but he noticed that each time he flexed the forearm to strike with a hammer he felt pains shooting from the elbow to the fingers, and he himself distinctly felt the jumping out of the "cord" at the inner side of the elbow. As a result, he was disabled for work.

Examination by Schwartz six weeks after the injury was as follows: In front of the elbow a long cicatrix; no evidence of fracture. On flexion of the forearm the ulnar nerve jumped to the front of the condyle, and in extension did not go back entirely behind, but rested on the epicondyle. The nerve could be moved into its groove, but would not stay there. The nerve was easily felt under the skin, enlarged, the size of a lead-pencil. Pressure on the nerve caused local and distributed pain. There was no atrophy, no anæsthesia, no paralysis, no trophic disturbances.

It was not considered worth while to attempt palliative treatment, therefore operation was done two months after the injury. Under general anæsthesia, with the forearm extended, the nerve was felt over the top of the condyle. On exposing the region (by what form of incision is not stated), the groove behind the condyle was found to be empty, and there was no trace of a fibrous aponeurotic bridge. The nerve was replaced in its groove and a flap of fascia from the epitrochlear muscles stitched over the nerve to the fascia covering the triceps; no drainage; an internal right-angled splint. At the end of eight days, primary union of the wound. Time that splint was left on is not stated. The result of the operation was that the nerve remained fixed in its groove during all motions of the forearm, but the patient was not relieved of the pains into

the finger and hand, and he also had some pain in the region of the wound on moving the arm.

Discussion of this case dwelt upon the question as to whether pain before and after the operation was not due to traumatic neuritis from the original injury instead of to the recurring dislocation.

CASE VIII.—R. LOZANO (*Revista de Medicina y Cirurgia Practicas,* Madrid, Tome xliii, 1898, p. 161). Male, farmer, aged thirty-five years; no morbid family or previous history. Fell to the ground while carrying heavy load on shoulder; immediately great pain in right arm at elbow. Pain increased, and in twenty-four hours had great weakness in right hand and forearm; pain made intense by movement of forearm. Soon was disabled for any work, and has been so for over two years. Examination found robust, healthy man. Flexion of right forearm and pressure on ulnar nerve at elbow caused lancinating pains into two inner fingers of hand; lack of sensation to pain and heat in the distribution of the nerve, and a subjective feeling of numbness in lower third of forearm; loss of muscular power in whole hand noted, but specially in flexing last two fingers, also some loss of power in spreading fingers. Curiously enough, since the injury patient has had in the palmar surface of hand following the distribution of the ulnar nerve patches of psoriasis. No lesion of elbow-joint or bones found; ulnar nerve dislocated in front of epicondyle. Lozano theorized that great muscular exertion made to save his load of wood as he fell caused rupture of fibrous band over the nerve.

Operation three years after the fall and first symptoms. No palliative treatment tried. Incision longitudinal, midway between olecranon and epicondyle. The nerve was put back in its groove, and a piece of the triceps muscle excised so that the nerve would not be pushed out of place; the fascia of the triceps was then sutured with catgut to the fascia over the forearm group of muscles; no mention of condition of fibrous structures back of condyle. No drainage; kind of immobilization not given. At the end of fifteen days sensation was restored in the anæsthetic areas; at the end of thirty days the muscular strength had returned. Result was a complete cure.

CASE IX.—JOPSON (*Philadelphia Medical Journal,* September 10, 1898, Vol. ii, p. 524). Case of a boy twelve years old. He had been engaged in violent snowballing for two days, but on the day before the first symptoms had a fall, the nature of which is not stated. Therefore the question of the causation of the dislocation is doubtful. (It will be remembered that in the case of Poncet, Case I, the etiology was in all probability violent use of the arm in snowballing). Pain, located especially over the internal condyle; no evidence of fracture; all relations of bones and muscles apparently normal. The ulnar nerve, on flexion of the forearm, dislocated over the internal condyle. Marked local pain and tenderness, and pressure on the nerve at the elbow caused tingling in the ulnar distribution in the hand. The relations of the ulnar nerve in the other arm were normal. An obtuse-angled splint, with pad over the nerve, was worn for a period of ten days in all. On removal of the splint, dislocation of

the nerve, with resulting pains, returned. Operation was done one month after the first symptom.

Incision made over the usual seat of the nerve, exposing about three inches of it. The groove of the nerve was either absent or filled up, and the fascia enclosing the nerve seemed to have been separated from the olecranon. The fascia covering the heads of the flexor muscles between the olecranon and the internal condyle was divided, and a longitudinal incision was made into the internal head of the triceps muscle above, and parallel with, the edge of its tendon. The nerve was placed in this muscular groove, and secured by two loops of kangaroo tendon around it and over the edges of the muscle. The fascia was then sutured over the nerve with catgut; no drainage; arm put up in extension on a straight splint, with a special pad over the internal condyle; no pain save slight tingling in the two inner fingers of the hand on the second day. Splint removed three weeks after the operation, when the nerve was found in place, and there was no pain or motion on pressure, save that flexion beyond a right angle caused some pain at the elbow. This pain, however, gradually disappeared; six weeks after the operation, case was pronounced cured. Nerve was firmly fixed, and there was no pain or luxation on motion.

Case X.—E. Damas, of Valance (*Le Bulletin Médical de Paris*, February 9, 1901, p. 119). This is a habitual case, but it is called "congenital" by Damas. Case of recurring dislocation of the right ulnar nerve for a period of four years in a man twenty-two years old. No history of trauma. In this case Damas describes a flattening of the internal condyle posteriorly on both elbows, and dislocation of the ulnar nerve on both sides, but with no symptoms on the left. Flexion of the right forearm caused pain into the little finger and numbness; increasing disability from this pain for four years. The dislocation of the left nerve was not known to the patient. He had been treated by ignipuncture and in other ways. The nerve was enlarged at the elbow and was fusiform in shape. No mention made of paralysis of sensation or motion, or of atrophy.

Operation.—Incision eight centimetres long, straight, over the tip of the epicondyle; detachment of periosteum from posterior face of the condyle, cutting a groove for the nerve with a gouge. (Nothing noted about condition of fibrous or muscular structures.) The nerve was covered over with a flap of fascia from the flexor group of mucles, which flap was sewed to the periosteum of the olecranon, folding the fascia in with silk Lembert stitches. No drainage used. No mention of splints after the operation; result stated to have been perfect. Damas states that congenital absence of the arcuate ligament and absence of a bony groove caused luxation of the nerve in this case. Damas is the only surgeon who thought it necessary to gouge out a groove in the bone.

Case XI.—Momburg (*Archiv für klinische Chirurgie*, Berlin, Band lxx, Heft 1, 1903, pages 215–232). Grenadier, twenty-one years old. On January 2, while exercising on a cross-bar, he felt a sudden snap and pain at right elbow-joint. Since this he has had swelling and pain at joint after exertion. Pain running into little finger, and felt especially on

forced extension and flexion. Trouble grew worse, and he was sent to the hospital.

Examination.—Muscular man. Right ulnar nerve on flexion of arm slipped over and below the internal epicondyle. Returned to normal position on extension. Forced movement caused characteristic pain. Same seen at left elbow, but here nerve only was dislocated to tip of epicondyle. No pain on left side. Both internal condyles seemed somewhat flat. In extension both nerves were exceptionally movable.

Momburg formed a new sheath in the normal place from fascial layers on February 15, 1902; the trouble recurred.

Second Operation, May 10, 1902.—Kind of incision and appearance of nerve not given. Formed a musculo-tendinous flap from the triceps by splitting the tendon by vertical incision of six to seven centimetres, following this by transverse incision towards the inner side of the arm at the top of the vertical one. The flap thus formed was carried under the nerve and back over it to its normal position and secured there with silk stitches. The nerve was thus made to run under and through the triceps tendon and fibres. Primary union with arm extended; passive motion in two weeks. Good result.

In discussion, he says that luxation of the ulnar nerve is frequent, but is only rarely seen because it gives no trouble, unless the nerve becomes inflamed.

Case XII.—M. Schwartz (*Bull. et Mémoires de la Soc. de Chir. de Paris,* 1903, n. s. xxix., p. 3). Man, twenty-nine years old; street-sweeper; well except for present accident. Two months previous, following violent effort to lift a load, felt much pain in right arm. Impossible to continue work. Each time he tried to push a broom he felt pain in forearm, especially in the last two fingers; paræsthesia. Had less strength in arm and was unable to raise a box above his head to dump it into the cart.

Inspection negative. Palpation shows a large cord which is displaced on flexion onto the top of the epitrochlear. Pressure with finger gives rise to tingling in last two right fingers. On extension of arm, nerve resumes its normal position.

Operation, November 29, 1902.—Straight incision between olecranon and epitrochlear. Nerve easily seen after incision of soft parts. Seemed that fibrous tissues which covered the nerve were very lax, if not actually thinned. Especially noticeable was the thickening of the nerve to twice the normal size. The enlargement was fusiform and extended about two centimetres. The epitrochlear was slightly less prominent than on well side. Groove for nerve seemed of normal depth. Schwartz cut a flap from the aponeurosis attached to the epitrochlear, turned it back and sutured it to the olecranon. No drainage. Arm bandaged at right angles.

One and one-half months later, patient can sweep easily, but still experiences some difficulty in raising a load above the head.

Cases XIII, XIV, XV.—Krause (Vortrag in der Sitzung des Aerztlichen Vereins in Hamburg am 31. October, 1899. Quoted from Momburg). Three cases. Details not given. Krause chiselled a periosteal bone-flap from the olecranon, turned it over, and sutured it with catgut

to the remaining periosteum covering the internal epicondyle. Cure of symptoms in all three cases.

Conclusions.—One must conclude that operation for this condition has every chance of perfecting a cure. It should be remembered that only the severe cases, few in number, and for the most part traumatic, need ever be operated upon. Operation should never be undertaken for dislocation of the nerve alone, but only for the symptoms caused by the recurring dislocation, and only in those cases in which the symptoms are severe and disabling. The steps of the operation are simple, and will necessarily be the same in the majority of cases.

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ONE THOUSAND ABDOMINAL CLOSURES BY A NEW METHOD, WITHOUT A KNOWN HERNIA.[1]

BY JAMES FAIRCHILD BALDWIN, M.D.,

OF COLUMBUS, OHIO,

Surgeon to Grant Hospital.

A HALF-DOZEN or less ventral hernias out of a hundred abdominal sections will give a surgeon far more annoyance, embarrassment, and worry than an equal number of fatal results. In regard to his fatal cases he may justly feel that all was done that human power could do, and that the result was inevitable; but with his hernias he cannot but feel that with greater care, or by a different procedure, the unfortunate result might have been obviated; and the unhappy patients and their friends are very apt to take the same unfavorable view of it.

According to the statistics carefully collected by Dr. W. D. Haggard, of Nashville, in an excellent article on the methods of closing abdominal incisions in *American Medicine,* of February 7, 1903, it is probably fair to assume that about 10 per cent. of abdominal sections closed by prevailing methods result in subsequent hernias. If the incision becomes infected, then at least 50 per cent. of hernias will follow. It would seem as though methods should be devised which would greatly reduce this percentage.

In a personal experience covering over 2000 celiotomies, I have used all the methods that have ever been seriously suggested, but have finally adopted a method which, in something over 1000 cases, has failed to show a single known hernia.

The through-and-through suture is recognized by all as giving unsatisfactory results, and it makes no difference whether silk, silkworm gut, or wire is used as the suture ma-

[1] Read before the Ohio State Medical Society, June 4, 1903.

terial. That method entirely fails to secure anything like coaptation of the fascia, unless it be by the merest chance, and a weak abdominal wall is almost a necessary consequence.

Buried silver wire, while securing accurate coaptation and ideal immediate results, is entirely unsatisfactory in the end. That the silver wire is sterile, or easily made so, is of course true; but the statement sent forth from Johns Hopkins, that the silver salts resulting from the contact of the tissues with the wire are slightly antiseptic, cannot be believed by those who have had any extended experience in the use of this material. It has happened scores of times in my work with silver wire that, six months to a year after apparently perfect union, the wire has become the source of suppuration, with the formation of an abscess which only healed after the wire was fished out. My experience with silver wire was absolutely and unequivocally disgusting, and I was not surprised when told by one of the leading surgeons of the Johns Hopkins Hospital, at the Philadelphia meeting of the American Medical Association, that that material was no longer so used at that institution. I have seen no published statement, however, to that effect.

Silkworm gut as a buried suture has all the disadvantages of silver wire, besides some peculiar to itself. Its ends cannot be bent down flat, and its surface may become quite rough. It is as unabsorbable as wire. A number of years ago I reopened an abdomen some five years after the appendages had been removed by a surgeon in Southern Ohio. For some reason he had used silkworm gut in closing the tops of the broad ligaments. There had been no infection, but there had been constant discomfort in the pelvis during the intervening years, and at the operation the broad ligaments, bristling with a dozen silkworm-gut sutures—as stiff and hard as when they were first inserted—appeared like a section of barbed-wire fence running across the pelvis. The use of buried silkworm gut, while advocated by a few surgeons not many years ago, has been, I think, abandoned by all. I used it in but a single case, and had to remove all those stitches subsequently.

Catgut, chromicized so as to last from two to four weeks, if it could be made assuredly sterile and be so kept until absorbed, would be absolutely the ideal material for closing the abdomen.

Catgut can unquestionably be rendered absolutely sterile, but in its introduction it is liable to become infected by the fingers of the operator, or by the instruments, sponges, or what not, in the field of operation. The surgeon's fingers, as the thread slips through them, are probably the greatest source of danger, but the other sources cannot be obviated entirely. If the gut once becomes infected, the infection will almost certainly extend from end to end of the wound, with resulting disaster. If the catgut is used only to bring the fascia together, and the rest of the wound is closed with through-and-through silkworm gut, then the occurrence of a single stitch abscess may infect the catgut, and again disaster will follow. (If catgut or kangaroo tendon is used, then rubber gloves should be worn by the operator when closing the incision, and every care taken to avoid any possible infection of the suture material. During the operation itself, I think rubber gloves objectionable, since, after a somewhat extended experience, I have found them to obtund too much the delicacy of touch which the operator so greatly needs; but this objection does not hold when it comes to closing the incision.)

One serious objection to the closing of the wound in layers is the formation of dead spaces between each layer. Usually no harm whatever results from these spaces, but sometimes an excellent culture medium collects and the slightest infection makes trouble.

A method by which the advantages of the tier suture can be obtained, but without dead spaces and without leaving behind any suture material after it has served its purpose, would seem to meet every requirement.

Of course, in cases in which the patient's condition is desperate, the through-and-through suture, being the most speedy, will uniformly be resorted to; and in cases in which drainage must be provided for, other than ideal methods of closure may

be necessary; but when the incision is of the ordinary character, when no drainage is necessary, and the abdominal walls present no obstacle, then the method suggested should certainly be employed.

Since June 19, 1897, I have used a method of closing the incision which seems to me to meet all the indications, and which in my hands has, so far as I can learn, in something over a thousand cases given perfect results.* At first I used silver wire, but I soon found that this did not possess the tensile strength to be satisfactorily used in that way, since it would occasionally break during its withdrawal. I therefore sought for some other material, and finally selected annealed iron wire, tinned. (This wire comes in various sizes, but I use No. 26. It can be obtained at the hardware stores, and costs twenty-five cents per box of one dozen spools. I have found this wire equally superior also in wiring bones.) It is strong, flexible, and tough, and is of course sterilized by boiling with the instruments.

In closing an ordinary abdominal incision made in the median line:

1. The bellies of both recti muscles are exposed so that they will be brought into direct apposition when the sutures are tightened. While muscular tissue in itself has little power to prevent a hernia, it nevertheless serves as an excellent buffer, and keeps the abdominal contents from direct impact against the line of closure of the fascia.

2. Through-and-through silkworm gut is then introduced, *from within out;* the needle being so introduced as to catch merely the edge of the peritoneum, and then passed well back through the muscle and fascia and out at a suitable distance from the skin margin.

3. The fascia is next brought together by an over-and-over stitch, using a doubled thread of either coarse silk or cotton. This is introduced into the needle so as to give a loop

* This method was first described by me in a little monograph on "Operative Gynæcology," issued in 1898.

about two feet long. To the end of this loop is attached the wire, which is sharply bent upon itself, so as to be readily drawn through the tissues, the loop being used merely as a guide for the easier introduction of the wire. The over-and-over stitch is so passed as to take in about a quarter of an inch of the edge of the fascia, and includes no other tissue. It is introduced very loosely, so that each turn can be caught later with the finger. As it reaches the end of the incision, it is passed from within out through fat and skin so as to make its exit an inch or more above the end of the incision. By means of this guide thread, the wire is introduced loosely so that it lies in the wound as a helix, the end of the wire appearing through the skin as the last of the thread is withdrawn. Care should be taken to see that the fascia, which is thus brought together, has been carefully cleaned of fat. This cleaning is best done when making the primary incision and before incising the fascia. By holding the belly of the knife at a suitable angle, the fat is easily separated for one-half inch on each side.

4. A handled needle with an eye at the point is then introduced through the skin and fat about an inch from the other end of the incision, and brought out just above the fascia so as to engage the other end of the wire, which is then withdrawn. This needle has been previously passed through two pads, about an inch square and made of six or eight thicknesses of gauze. Before withdrawing the wire from the needle, one of these gauze pads is slipped down over the wire so as to rest next to the skin. The other end of the wire is then threaded through the needle and the other gauze pad placed in position, and a perforated shot placed outside of each pad.

5. The incision is then carefully dried, if there has been any oozing, and while an assistant draws up the ends of the silkworm gut, so as to secure apposition of the peritoneum throughout, the wire helix is drawn straight by traction with forceps on each end, care being taken to see that no kinks are formed during this process. The wire should be drawn back and forth once or twice so as to be sure there are no kinks.

The perforated shot are now pushed down against the pads and clamped.

6. The fascia is thus held in absolute contact, and the operator can *see* that not a bit of fat or muscular tissue intervenes. The silkworm gut is then tied in the usual way, care being taken that it is not drawn too tight, as this is probably the most common cause of stitch abscesses. The use of the silkworm gut precludes any possibility of dead spaces; all the tissues are brought into absolute contact, layer to layer.

In an abdominal wall enormously thickened from a deposit of fat, this method cannot be used, since the pressure of the silkworm gut would be too great. Here I usually close the peritoneum, including the transverse fascia, with fine catgut; the muscle and fascia in two layers with chromicized catgut No. 1, which will last three or four weeks, and then the skin and fat with through-and-through silkworm gut, so as to secure good, but not tight, apposition. Gloves are always used in closing incisions in this way. In order to drain the dead space between the fascia and fat, a wick is introduced of iodoform gauze, wrapped in gutta-percha tissue, which extends from the upper end of the wound throughout its entire length and is brought out at the lower angle of the incision, this being introduced, of course, before the silkworm-gut stitches are tightened. Any oozing that takes place will be carried off by this wick, which is withdrawn the next morning.

In cases in which the recti muscles are widely separated, no attempt is usually made to bring them together, but extra care is taken to secure apposition of the fascia.

The line of incision is supported by a snug binder of canton flannel, made in the form of a many-tailed bandage. The bandage is so made that each strip overlaps the one below by about one-half its width, and they are stitched together up and down at the back by two lines of stitches several inches apart, so that there is little tendency for the binder to be thrown into folds.

If the case does well, the dressings are not removed from over the wound until the tenth day. (The bandage can, of

course, be removed at any time if it becomes soiled.) The dressings are then removed and all sutures withdrawn. The wire having been drawn straight at its introduction is one of the easiest stitches to withdraw at this time. The gauze pad at one end is caught with the fingers and the wire drawn out a little beyond the skin and cut off. Traction at the other end results in its easy withdrawal. If a stitch abscess occurs, then the affected stitch is at once withdrawn, and, if it seems best, one or two on each side; but the wire is not disturbed until the usual time. The bandage is reapplied, and is worn continuously as long as the patient remains in the hospital,—usually about three weeks. She is then directed to wear a similar bandage day and night for one month, except as it is removed for bathing, and then to wear it during the day for still a second month. At the end of that time, about three months altogether, she is directed to discard it entirely. Experiments upon animals have shown that healing is complete at the end of three months. To wear a bandage longer than this time is therefore unnecessary, while the weakening of muscles, as the result of prolonged support, is undesirable. The use of the bandage is simply to support the parts during the healing process, so that they may not be separated by any sudden strain or effort.

If other surgeons have used this method before the date mentioned, I have no knowledge of such fact. I know of a number of surgeons who are using this method now, having seen it employed in my clinic. I have not undertaken to trace up all the patients upon whom I have used it, but, as I have heard from the usual number of post-operative hernias in which I had closed the incision by other methods, I believe that I would have heard from some hernias resulting from this method if many of them had resulted. Moreover, with few exceptions, the patients operated upon have not been of the class which drifts around from hospital to hospital, as in the large eastern clinics, but have been almost entirely what would be called private patients.

SPLENECTOMY FOR BANTI'S DISEASE,

FOLLOWED BY THROMBOSIS OF THE RIGHT INTERNAL JUGULAR, SUBCLAVIAN, AND INNOMINATE VEINS. RECOVERY.

BY CHARLES G. LEVISON, M.D.,

OF SAN FRANCISCO,

Associate Professor of Surgery in the Post-Graduate Department, University of California; Visiting Surgeon to the City and County Hospital and the Mount Zion Hospital; Consulting Surgeon to the California Eye and Ear Hospital.

THAT splenic anæmia has been but imperfectly understood may be readily seen by a reference to the designations of this symptom complex given by various authors. Eichorst described it as splenic pseudoleukæmia, Cohnheim as pseudoleukæmia, Banti and Gretsel as splenic anæmia, Gaucher as idiopathic hypertrophy of the spleen, De Bove as hypertrophy of the spleen without leukæmia. That this still remains an obscure question is apparent, for Osler,[1] in his latest publication, states as follows: "The question of the existence of a separate malady—Anæmia Splenica—is still in what might be called the inquisitive or the tentative stage."

Sippy[2] as well as Osler,[3] in a series of cases of splenic anæmia, describe a condition more or less characteristic, having the following clinical picture: The disease occurs in young adult life, developing insidiously, oftentimes without any manifestation, until the sudden appearance of hæmorrhage, which generally proceeds from the stomach. This symptom may be the first trouble experienced by the patient and causes him to seek medical advice. The disease is frequently accompanied by dizziness and a slight pallor, due to anæmia. In a number of Osler's cases the anæmia was not profound.

The attention of the patient is often attracted to a tumor in the left side, which may be the first indication of the disease. Nausea, vomiting, epistaxis, profuse and protracted diarrhœa frequently occur. As the tumor increases in size, the patient complains of a dragging sensation in the side, but few expe-

rience any pain. Bronzing of the skin is frequent (melanoderma). This was present in about 60 per cent. of Osler's cases. Harris [4] reports the disappearance of this pigmentation subsequent to a splenectomy for splenic anæmia. There is no lymphatic involvement which differentiates it from Hodgkin's disease. The liver may or may not be enlarged. Œdema and ascites may develop. Hæmorrhages are very frequent, death at times resulting from profuse bleedings or exhaustion.

The blood findings are fairly constant. Reds about 3,500,000; a low color index showing a diminution of hæmoglobin disproportionate to the number of red cells (secondary anæmia of the chlorotic type). In the greater number of cases leucopænia is present, generally below 5000. There are no nucleated red cells, nor does the differential count reveal anything of significance: no myelocytes, excluding leukæmia. In several of Osler's cases ascites was present.

Banti [5] describes a condition which develops in three stages, and is characterized by cirrhosis of the liver, splenomegaly, and ascites. In the first stage, anæmia and splenic enlargement are present, the anæmia being secondary to the enlargement of the spleen. The duration of this period varies between three and ten years, and is followed by a second stage marked by a diminution in the quantity of urine, and an increase in bile pigment and urates: this continues for several months, then follows the third and most characteristic stage, distinguished by the development of ascites, which appears insidiously and is unaccompanied by pain. The anæmia increases, and at times there is an evening rise of temperature. Banti states that there is a slight increase of white corpuscles, but most observers agree that leucopænia usually exists. Death occurs within a year after the disease has fully developed (Senator [6]).

To Banti belongs the credit of having simplified our knowledge of the pathology of these conditions. It was he who first claimed that the cirrhosis of the liver was secondary to the enlargement of the spleen, which is contrary to what obtains in primary cirrhosis of the liver. He also maintained

that the splenic enlargement was due to a toxæmia, the products of which, passing through the liver, cause an hyperplasia of the connective tissue, such as occurs in the liver of alcoholics. As the disease is accompanied by ascites, the toxæmic theory would have material support, for the spontaneous disappearance of the ascites in Banti's disease is evidence that portal obstruction, in consequence of interstitial hepatitis, does not exist.

Barr [7] advances the following theory in reference to Banti's disease; that it is due to a vasomotor paresis of the splanchnic area, which arises from a disease of the visceral sympathetic ganglia. This results in an engorgement of the abdominal viscera, especially the liver and spleen, with hæmolysis as a consequence, and which is followed by oligochromia and oligocythæmia. The increased blood supply leads to fibrosis and lessened function; it also causes the peritoneal effusion, which is in no way dependent upon portal obstruction. The vasomotor paresis which lowers blood pressure leads to a retention of blood in the portal circulation; hæmorrhage and impaired digestion being the result of this engorgement.

Infection has been considered an etiological factor, but bacteriological investigations up to this time have resulted negatively. In the etiology, the digestive tract must be considered; to this Senator calls attention on account of the diarrhœa.

The development of the disease, with its consequent ascites, at once attracts attention to the liver, which we ordinarily consider the causative factor in the development of ascites. Pousset,[8] in an analytical study of the relative size of the liver and spleen, states that in cirrhosis of the liver the spleen is moderately enlarged compared to the size of the liver, while in Banti's disease and splenic anæmia the spleen may often exceed the liver in size.

Senator [9] reports a case of Banti's disease accompanied by marked ascites, which necessitated the removal at different intervals of twenty-five litres of fluid. Eventually the fluid did not reaccumulate, entirely disappearing. He remarks that if interstitial hepatitis were present, it would be unusual for the

fluid to disappear in this manner, as this is not the history of ascites complicating cirrhosis of the liver.

Senator accounts for the disappearance of the fluid by reasoning that enlarged mesenteric glands which have been reported to exist, may open a collateral lymphatic circulation, and so relieve this stasis of lymph. Hæmorrhagic tendency, the most important symptom, remains to be mentioned. Bleeding may occur in the form of epistaxis, a very common manifestation, or it may appear as hæmatemesis. Purpura, also hæmorrhage into the vitreous body, are occasionally seen. The gravest of all, however, is the bleeding that proceeds from the stomach, and which may result in death. In all probability, some of the cases of so-called cirrhosis of the liver, with enlargement of the spleen, complicated by hæmatemesis, have in reality been either splenic anæmia or Banti's disease. If this assumption is correct, these conditions will be oftener recognized as their true nature becomes better known. The bleeding may be the first symptom of the disease, and the anæmia its consequence.

Senator [10] has collected all of the cases (up to the publication of his paper) where it was possible to obtain a complete report; many of these have been considered splenic anæmia, but which he thinks should be classified as Banti's disease. He states that the blood findings are fairly uniform, presenting the combination of oligocythæmia, oligochromia, and leucopænia. This combination, however, is found in well-developed cases only, for the leucocyte count is more or less dependent upon other factors, such as hæmorrhage, infection, etc. Here a leucocytosis due to a pneumonia or other infectious process would cause alterations in the blood. In one of Harris's cases there was a leucocytosis of 28,000.[11]

A recapitulation of the blood findings shows

First; oligocythæmia. There is a diminution of the red cells, the average being about 3,500,000.

Second; oligochromia. The low percentage of hæmoglobin is fairly constant, and is marked by a low color index; in pernicious anæmia the contrary obtains.

Third; leucopænia. This is quite constant. Osler reports that out of thirteen cases, nine gave a leucocyte count of less than 5000; in six of these cases the leucopænia was extreme. The red cells and the differential count reveal nothing of diagnostic value. Senator states, however, that the cases on record have been too few to warrant the statement that the blood findings in Banti's disease are quite characteristic.

In conclusion, it is evident that Senator considers Banti's disease as a disease characterized by an enlargement of the spleen without lymphatic involvement, tendency to hæmorrhage, oligocythæmia, oligochromia, leucopænia, and accompanied by ascites. Cirrhosis of the liver may or may not be present. He considers the disease as splenic anæmia with ascites.

Osler's [12] deductions upon this symptom complex are apparent from the following definition of anæmia splenica chronica which he offers: "A chronic affection, probably an intoxication of unknown origin, characterized by a progressive enlargement of the spleen, which cannot be correlated with any known cause, as malaria, leukæmia, syphilis, cirrhosis of the liver, etc. (primary splenomegaly); anæmia of a secondary or chlorotic type (leucopænia); a marked tendency to hæmorrhage, particularly from the stomach; and in many cases a terminal stage with cirrhosis of the liver, jaundice, and ascites (Banti's disease)."

That surgery of the spleen has made great strides during the past decade may be readily seen by a reference to the monograph of Bessel Hagen [13] upon this subject, and which still remains the most important contribution to the literature. His statistics include a number of surgical diseases of the spleen, which, however, have no place here; but in the disease that concern us the following figures demonstrate how materially the death-rate has fallen during the past decade.

In fifteen cases of extirpation of a wandering spleen due to malaria there was one death (6.6 per cent.). In sixty-nine cases of extirpation of the spleen for malarial hypertrophy there were six deaths (8.7 per cent.). The mortality was

in reality 23.4 per cent.; but by eliminating cases in which there had been errors in technique and diagnosis, together with improper selection of cases for operation, Hagen figures the mortality in favorable cases to the above. In twenty-eight cases of wandering spleen with idiopathic hypertrophy there were two deaths (7.1 per cent.). The statistics in general show that out of 131 splenectomies for different causes there were sixteen deaths (12.2 per cent.). As stated before, errors which might have been obviated, such as slipping of ligature, sepsis, etc., have been eliminated. With these not eliminated, the mortality remains 18.9 per cent. against 42.2 per cent., the mortality before 1890.

The number of cases of splenic anæmia and Banti's disease which have been treated by splenectomy prove how much can be accomplished by surgical measures, for, if not treated in this manner, the disease usually terminates fatally. It is just here that great stress should be laid concerning an accurate diagnosis; for in the experience of many, patients have died of recurrent hæmorrhages, where the usual diagnosis of cirrhosis of the liver has been made upon the clinical findings, namely, cirrhosis of the liver, enlarged spleen, and hæmatemesis being present. In some of these cases life might have been saved by a correct understanding of the pathology, together with an accurate diagnosis, followed by early surgical interference. In subjecting these cases to operation, the diagnosis is of the greatest importance, for the mortality in splenectomy has been materially increased as a result of improper selection of cases. Mariagliano [14] and Terrille [15] report a series of sixteen cases of Banti's disease treated by splenectomy with three deaths. In this series there was an uncertainty of diagnosis in two cases, death in both instances resulting from uncontrollable bleeding. In the other case death was due to a perforation of the uterus during curettage for an abortion, the consequence of a splenectomy.

Warren [16] reports a splenectomy performed for splenic anæmia, and Harris [17] reports two cases operated for the same condition. All recovered. Immediately after splenectomy

for these conditions, there is an increase of the red and white corpuscles without a corresponding increase in the hæmoglobin; following this there is a diminution of the reds which persists for several months, when the reds gradually reach a high figure. The high leucocyte count as well as the low color index persist for a long time. Harris calls attention to the large percentage of eosinophiles (14.4 per cent.) that was observed in one of his cases; in this case a number of red cells (hazy) and many microcytes were found as late as twenty months after the operation.

The following case of Banti's disease presents several points of interest.

E. S., aged twenty-seven years; male; weight in health, 185 pounds; habits regular; does not drink to excess. Family history negative. No history of malaria or syphilis. In 1894 patient developed an acute appendicitis with perforation, for which he was operated by the writer. Two days subsequent to the appendectomy, a toxæmia developed in consequence of an accumulation of fluid in an acutely dilated stomach. The patient vomited great quantities of an offensive blackish fluid, and appeared to be "in extremis;" temperature, 104.5° F.; pulse, 150. As a last resort, the stomach tube was introduced, when great quantities of this fluid were evacuated. The temperature and pulse dropped immediately. Convalescence uninterrupted. This case had several points of interest which were at the time reported.

Up to 1896 the patient had remained in good health, playing cricket, etc. One day, without warning, he was suddenly seized with a hæmorrhage from the stomach, vomiting large quantities of red blood, also passing blood by rectum. During this time he had never experienced any pain in the epigastrium, nor had he any cough. Anæmia was the sequel of this bleeding; the patient, however, recovering completely. In 1897, one year later, he had a similar experience, supposed at the time to be due to a strain. This attack was more severe than the previous one, and confined the patient to bed for six weeks; but he subsequently regained his usual health. In May, 1901, being four years later, the patient again vomited blood profusely for three days; recovery again complete. On November 28, 1901, he was in perfect health,

stating that he never felt better in his life, when he was suddenly seized with a hæmorrhage from the stomach of a most alarming nature. He was seen by the writer thirty-six hours later and found to be almost exsanguinated. This bleeding recurred at intervals for three days, the blood being bright red and the stools tar-colored. No pain.

November 30, 1901. Face very anæmic, lips blanched, pupils moderately dilated, reacting to light. Pulse, 96; full but compressible. Hæmic murmur. Abdomen: dulness continuous with the splenic dulness, extending from the upper seventh rib sixteen centimetres downward in the midaxillary line, and continuous with the heart dulness. It also reaches to the same height posteriorly. The mass is easily palpated and slightly movable; notch can be felt. Liver, upper sixth, costal margin. Urine, 1080 cubic centimetres in twenty-four hours. Urea, 2¾ per cent.; traces of albumen, quantities of granular casts, some few red blood-corpuscles.

Blood examination: hæmoglobin, 30 per cent.; leucocytes, 5000; reds, 2,500,000.

December 2. Vomited matter contains no blood.

December 3. Dulness remains the same. Vomited 420 cubic centimetres of blood. Hæmoglobin, 25 per cent.; reds, 2,800,000; whites, 28,000; temperature, 101.8° F. Slate-colored stools. (Note the leucocytosis and accompanying temperature together with the slate-colored stools, all of which might indicate an infection emanating from the intestinal tract.) Patient very weak; 200 cubic centimetres of a 2½ per cent. gelatin in normal salt solution were injected, after which the hæmorrhage did not recur.

December 4. Patient improving.

December 12. Dulness extends from the upper seventh seventeen centimetres downward in the midaxillary line, and across from the costal angle to the median line.

January 15. Hæmoglobin, 25 per cent.; reds, 2,800,000; whites, 4000. Patient suffers greatly from insomnia due to an intense pain between the scapulæ, necessitating the use of very large doses of morphine without material relief (up to four grains hypodermatically within four hours). This pain caused the patient more suffering than all of the other symptoms combined. It persisted about one month and then disappeared.

Liver-dulness: upper sixth, costal margin (no enlargement),

splenic dulness upper seventh rib, seventeen centimetres in the midaxillary line. Dulness extends to eleven centimetres on either side of the umbilicus and moves upon change of position (ascites). No anasarca. Patient has been passing slate-colored stools for three weeks: they are not clay-colored, but are bluish in appearance.

January 25. Fluid in the abdomen continues to increase. The veins lateral to the umbilicus are visibly distended; no distention of the veins surrounding the navel. Paracentesis abdominis, three litres.

February 9. Fluid reaccumulating; paracentesis about to be repeated, when the disappearance of the distended abdominal veins was observed, and, as this pointed to the re-establishment of the portal circulation, it was not carried out. The subsequent history confirmed this belief, for the fluid gradually disappeared, and did not reform.

Blood: reds, 2,537,000; whites, 4200; hæmoglobin, 22 per cent.; plasmodium none.

Differential count: polymorphonuclear neutrophiles, 86.8 per cent.; small lymphocytes, 6.06 per cent.; large lymphocytes, 6.31 per cent.; eosinophiles, .75 per cent.

Five hundred leucocytes counted; one megaloblast was seen (large nucleated red cell). There is a marked diminution of hæmoglobin in each cell. A very decided variation in the size of the red cell exists, many microcytes being present; also a few megalocytes and poikilocytes.

March 16. Reds, 2,074,284; whites, 1300 (note the low white count); hæmoglobin, 44 per cent.; (Fliesch), 38 per cent.; (chloroform benzol), plasmodium none.

Differential count of leucocytes: polymorphonuclear neutrophiles, 79 per cent.; large lymphocytes, 10.5.; small lymphocytes, 4.5 per cent.; eosinophiles, 6 per cent.

No myelocytes were seen. The small lymphocytes invariably show perinuclear basic granules; this, however, has no special significance. The red cells all stain feebly, and are variable in size; numbers of microcytes, megalocytes, and poikilocytes being present. Very few normal red cells are found. One large nucleated red cell (megaloblast) was observed.

March 23. Reds, 3,066,000; whites, 1450; hæmoglobin, 45 per cent.; (Fliesch), 45 per cent.; (chloroform benzol); plas-

modium none. Examination of stained specimens showed the same condition as existed one week before, with the exception that there is less variation in the size of the red cells.

March 26. Patient rapidly improving, has gained twenty pounds. Liver, upper sixth, costal margin, nine centimetres in the mammillary line; spleen extending almost to the iliac crest, seventeen centimetres in the midaxillary line; painless; notch easily felt.

March 29. Reds, 3,387,480; whites, 1925; hæmoglobin, 43 per cent.; plasmodium none.

Differential count of leucocytes: polymorphonuclear neutrophiles, 77.5 per cent.; large lymphocytes, 13.4 per cent.; small lymphocytes, 6.7 per cent.; eosinophiles, 1 per cent.

A good many megalocytes (3 to 4 per cent.) as well as microcytes (25 to 30 per cent.) are present, together with a moderate number of poikilocytes. There are a few shadow cells. The red cells more nearly approach the normal than at any previous examination. One large nucleated red cell was seen.

April 6. Reds, 3,156,666; whites, 1550; hæmoglobin, 40 per cent. (chloroform benzol).

Differential count: polymorphonuclear neutrophiles, 88.5 per cent.; small lymphocytes, 6.5 per cent.; large lymphocytes, 2 per cent.; eosinophiles, 3 per cent.

The red cells stain better than on previous occasions, and the number of normal cells is larger than heretofore, the number of shadow cells and microcytes being less.

That the foregoing case is one of Banti's disease the writer believed to be evident, each symptom conforming to the picture described by Banti and other observers.

After a careful consideration of the indications for the removal of the spleen as a life-saving expedient, and in view of the history of the case, together with the blood findings, splenectomy was advised and acceded to. Patient in excellent condition, notwithstanding his 40 per cent. of hæmoglobin; deeply bronzed; was accosted on the street by friends, who inquired of him if he were not jaundiced. The writer remarked that the patient resembled a Chinaman. This melanoderma, which was apparent all over the body, seemed to be growing darker. Liver and spleen as before noted. Urine: no albumen or sugar; casts absent; urea, 2.8 per cent.

April 8, 1902. Under chloroform narcosis an incision was made in the left semilunar line, extending from the left costal angle to the level of the navel. The blood which flowed from the incision was seen to be very light in color and quite watery. The spleen was readily exposed and palpated in its entirety. Diaphragmatic adhesions were absent, but the splenodiaphragmatic ligament was readily felt connecting the organ to the diaphragm. Great difficulty was experienced in delivering the spleen on account of the shortness of the pedicle, which consisted of the peritoneal fold, including the splenic vessels, constituting the gastrosplenic ligament. The first attempt at ligation was followed by an alarming hæmorrhage due to the tearing of one of the large splenic sinuses; this hæmorrhage could only be controlled after the spleen had been delivered, which became possible when the ligament extending to the diaphragm was tied off. This permitted the delivery of the upper end of the organ, after which the entire spleen was lifted out and turned from left to right, the pedicle being exposed from below. Warren, in his splenectomy for splenic anæmia, had a similar experience. It was necessary, however, to enlarge the incision, by making a supplementary incision extending from the middle of the vertical incision horizontally to the left for a distance of about three inches. Warren extended his incision to the right, cutting across the rectus. The pedicle was ligated in sections tied double and cut between; extra ligatures applied to the individual vessels, to avert secondary hæmorrhage; chromic gut was used. The vessels of the greater omentum were enormously enlarged, but were not interfered with on account of the necessity of maintaining a collateral circulation, possibly obviating a recurrence of ascites. There was considerable hæmorrhage from oozing low down from the diaphragm, near the spinal column. This was controlled by gauze packing, which was allowed to remain thirty-six hours. No shock from the operation, notwithstanding the fact that there was considerable loss of blood. Color good when removed from the table. Duration of operation, one and one-half hours, most of the time lost in controlling oozing. Pulse 72, good. Compress shows considerable oozing not sanguinolent. 4 P.M. Pulse, 82; temperature, 100.6° F.; urine, 390 cubic centimetres by catheter.

April 10, 6 A.M. Pulse, 92; temperature, 99.6° F.; respiration, 22; urine, 1140 cubic centimetres in twenty-four hours.

Some of drain removed. At this time the melanoderma seemed to be fading, more especially on the body; this was remarked by every one who saw the patient. Ears and lips a brighter red than before the operation. 6 P.M. Pulse, 100; temperature, 100.6° F.; respiration, 24. Whites, 24,780; reds, 3,100,000; hæmoglobin, 50 per cent.

April 11, 6 A.M. Pulse, 94; temperature, 100° F.; respiration, 24; urine, 1740 cubic centimetres in twenty-four hours. Drain removed. Bowels moved with calomel.

Blood examination: reds, 3,100,000; whites, 15,500; hæmoglobin, 55 per cent.

The red cells in general stain better than before the operation; there are a few pale cells as well as a few of abnormal size and shape. The general impression received being that the blood is much nearer normal than at any previous examination.

Differential count of leucocytes: polymorphonuclear neutrophiles, 81 per cent.; small lymphocytes, 3 per cent.; large lymphocytes, 16 per cent.; no eosinophiles; 500 white cells counted. A considerable number of anomalous forms are seen, and which can be separated into two classes, viz.:

First, polymorphonuclear cells without or with few granules (quite unusual); second, large lymphocytes with deeply indented nucleus, apparently about to divide (transitional form).

April 12, 6 A.M. Temperature, 100.6° F.; urine, 960 cubic centimetres; hæmoglobin, 55 per cent. 6 P.M. Temperature, 101° F.

April 13, 6 A.M. Temperature, 100° F.; urine, 900 cubic centimetres in twenty-four hours. 6 P.M. Temperature, 101.2° F.

April 14, 6 A.M. Temperature, 100.6° F.; urine, 900 cubic centimetres in twenty-four hours; urea, 3 per cent. 6 P.M. Temperature, 102.2° F.; pulse, 96.

Blood examination: Reds, 3,112,000; whites, 12,000; hæmoglobin, 57 per cent. (von Fliesch).

Differential count of leucocytes: polymorphonuclear neutrophiles, 73.9 per cent.; large lymphocytes, 18.1 per cent.; small lymphocytes, 0.7 per cent.; eosinophiles, 1.9 per cent.

Twelve nucleated cells counted: normoblasts, 10; megaloblast, 1; microblast, 1.

April 15, 6 P.M. Temperature, 101° F.; urine, 720 cubic

centimetres in twenty-four hours; urea, 3 per cent. Patient convalescent, wants to know when he can get up. There is no evidence of enlargement of either lymphatics or of the thyroid gland.

Reds, 3,064,000; whites, 8000; hæmoglobin, 55 per cent.

No differential count was made. The various forms of leucocytes, however, seemed to be in the same proportion as at the last examination. Special staining failed to show the presence of any mast-cells. The red cells were mostly fairly normal in size and staining properties. A few normoblasts were seen, no distinct megaloblasts.

April 21. Hæmoglobin, 55 per cent.

Leucocytes: polymorphonuclear, 86 per cent.; large lymphocytes, 11.25 per cent.; small lymphocytes, 1.6 per cent.; eosinophiles, 1 per cent.

Red cells: a few macrocytes and microcytes are seen, also a very few poikilocytes. In counting 700 leucocytes, sixteen nucleated reds are seen, classified as follows: twelve normoblasts, two microblasts, two megaloblasts. The latter were rather doubtful, and were classed as megaloblasts on account of the staining properties of the nucleus rather than on the size of the cell. The large majority of reds are normal or nearly so, as seen in the stained specimen.

April 25. Reds, 2,922,000; whites, 12,400; hæmoglobin, 56 per cent.

Leucocytes: polymorphonuclear, 79 per cent.; mononuclear large, 10.5 per cent.; mononuclear small, 9.5 per cent. Of the latter, an unusually large number are rather medium sized and difficult to classify as large or small. In counting 500 whites, one mononuclear and one polynuclear basophile were seen.

Red cells: only two nucleated cells were seen, one being a normoblast and one a microblast. There is a decided reduction as compared to the last examination. Macrocytes and microcytes are not numerous; the large majority of red cells being normal in size and staining reaction.

April 26, 6 A.M. Temperature, 99° F.; P.M., 100° F. Patient complains of pain on the right side of the neck. Sternomastoid very sensitive to pressure, postcervical glands enlarged. Pain extends from the right shoulder to the mastoid region. Axillary glands not palpable; cubital gland on the right side much

enlarged; sublingual glands swollen and painful. Thyroid gland enlarged and painful.

April 30. Neck very painful; inguinal glands indurated and enlarged. A large indurated mass is felt under the sternomastoid on the right side; left side unaffected. Temperature, 101.8° F.; 6 P.M., 102.2° F. Swelling extends from the sternoclavicular articulation to the ear. No superficial induration.

May 1. Temperature, A.M., 102.2° F.; pulse, 100. Neck, shoulder, and arm enormously swollen. The diagnosis of a deep-seated cervical abscess was made and operation decided upon. The patient's condition was quite alarming; sensorium dulled.

Blood examination prior to the operation was as follows: Hæmoglobin, 50 per cent.; red cells not estimated; leucocytes, 30,500.

Differential count: polymorphoneutrophiles, 85 per cent.; large lymphocytes and transition forms, 12 per cent.; small lymphocytes, 2 per cent.; eosinophiles, 0.5 per cent.; mast-cells, 0.5 per cent.; myelocytes none. Nine hundred white cells were counted. Nucleated red cells were seen as follows: five normoblasts and one microblast. The red cells in general seem to be not far from normal, very few of abnormal size and shape are seen. Under ether narcosis, an incision was made along the inner border of the sternomastoid, but no pus was found. The internal jugular was easily exposed, and seen to be firmly distended with a clot. On account of the mottled appearance of the wall of the vessel, it was incised and the clot laid bare. No evidence of pus could be discovered. The vein was then followed from the mastoid down to the sternal articulation, a thrombosis of the entire vessel being disclosed. An incision, such as is usually done in ligating the subclavian, was made above the clavicle, in the hope that the entire thrombosed vessel might be excised; but the exposure of the subclavian vein as well as the right innominate vein behind the sternoclavicular articulation showed how futile that procedure would be. Both the subclavian and the innominate veins, which were distended with clot, could be easily followed behind the sternoclavicular articulation up to the superior vena cava as easily as it is followed upon the injected cadaver. Further manipulation was desisted from; the internal jugular was tied and cut at the point of incision and the wound closed. The patient reacted well from the operation, and after two days

th swelling began to subside, and within two weeks it had almost disappeared. Coincident with the subsidence of the swelling, the superficial veins of the shoulder and back on the right side became much dilated, evidently due to the establishing of a collateral circulation; this dilatation was present after one year, but has now about disappeared.

That we had a thrombosis of the right innominate vein was evident at the time of operation; that the left innominate was not involved was apparent by the absence of all manifestations on the left side; hence we are warranted in assuming that the superior vena cava remained patent. From this time on convalescence was unimpeded, excepting for the persistence of severe sweating, which gradually ceased.

May 7. Reds, 2,800,000; whites, 32,000; hæmoglobin, 50 per cent.

Differential count: polymorphonuclear, 80.5 per cent.; small lymphocytes, 2 per cent.; large lymphocytes, 13.5 per cent.; mast-cells, 1 per cent.; eosinophiles, 3 per cent.

Nucleated red cells were fairly numerous in counting 400 leucocytes, and consisted of thirty-five normoblasts and two microblasts. Some of the normoblasts showed dividing trilobate and quadrilobate nuclei.

May 20. Reds, 3,700,000; whites, 9300; hæmoglobin, 61 per cent.

Differential count of whites: polymorphonuclear neutrophiles, 61.5 per cent.; large lymphocytes and transition forms, 22.5 per cent.; small lymphocytes, 12.5 per cent.; eosinophiles, 3.5 per cent.; mast-cells, 0.5 per cent.

One nucleated red cell was seen, that a normoblast. Considerable variation in the size of the red cell exists.

July 6. Red cells, 4,268,000; whites, 7600; hæmoglobin, 63 per cent.

Differential count: polynuclear neutrophiles, 67.5 per cent.; large lymphocytes and transition forms, 23 per cent.; small lymphocytes, 8 per cent.; eosinophiles, 1 per cent.; basophiles, 0.5 per cent.

Red cells: nucleated forms, a few are present; four or five to one cover slip preparation, all being normoblasts. The only deviation from the normal being a considerable variation in the size of the cells, and failure of some to take the stain well (dimi-

nution of hæmoglobin). After this the blood became quite normal and has remained so up to date. The patient has gained about sixty pounds, has had no further hæmorrhages, and says that he feels stronger and better than he has felt for years. There is no glandular enlargement nor is there any swelling of the right arm. Melanoderma entirely disappeared.

The following blood examination was made June 3, 1903, this being about fourteen months subsequent to the splenectomy. Red cells, 6,400,000; whites, 9500; hæmoglobin, 96 per cent.

Differential count (500 leucocytes); polymorphoneutrophiles, 81.8 per cent.; large mononuclear and transitional forms, one per cent.; small mononuclear, 15.4 per cent.; eosinophiles, 8 per cent.

Pathological report of excised spleen made by Dr. Arthur L. Fisher, pathologist to the Mount Zion Hospital.

The spleen has been preserved in 4 per cent. formaldehyde solution since the day of the operation. It now measures 21.5 centimetres by 14.5 centimetres by 8 centimetres, and its weight, wet, 1350.0 grammes.

Paraffin sections were made and stained in hæmatoxylin and eosin, eosin and methylene blue, and in carbol fuchsin and hæmatoxylin (for tubercle bacilli). The sections stained for the tubercle bacilli did not show any, and those stained in eosin and methylene blue failed to reveal the presence of any other micro-organism. None of the sections stained well.

The capsule of the spleen is very much thickened, as is the connective tissue throughout the spleen. Around the larger vessels this is particularly noticeable; some of the largest vessels are surrounded by a dense band of thick fibrous tissue. In a few of the medium-sized vessels just below the capsule the blood still remains; in other places it has escaped,—probably simply run out when the spleen was cut, as there is practically nothing to indicate that the blood supply has been interfered with to any extent.

There is a great deal of iron free blood pigment (hæmatoidin) throughout the spleen, both in the central and in the peripheral portions, but more in the periphery than in the centre. The pigment is deposited mainly in the interstices between the cells. There is very little evidence of active phagocytosis; only here and there are seen a few polymorphonuclear leucocytes containing pigment and other detritus. There are none of the large

endothelial phagocytic cells to be seen. The Malpighian bodies are apparently not increased in size nor relatively in number. Absolutely there is probably a considerable increase in number. The vast majority of these bodies are normal in appearance; a few, however, are undergoing hyaline degeneration at their centres, and occasionally one is seen in which almost the entire body has undergone hyaline degeneration. The increase in the size of the spleen is to be accounted for mainly by an increase in the number of certain of its component cells, notably the elongated more or less fusiform fibrous tissue cells, the endothelial cells, and to a lesser extent the lymphoid cells. The cells are closely crowded, apparently obliterating the smaller spaces and pressing the walls of the sinuses together. In the central portion it appears as though the spaces are completely lined with endothelial cells. This, in connection with the increase of the supporting fibrous tissue, gives the spleen a glandular appearance. The capillaries in the fibrous tissue are very abundant.

The endothelial cells are rather small for cells of this kind. The nucleus is slightly more solid than is usually seen in endothelial cells. It is somewhat larger than the nucleus of a lymphocyte, and is surrounded by a cell body of a rather poorly staining protoplasm.

The larger vessels show quite a marked thickening of the intima. The main changes are increase in the fibrous tissue; proliferation of endothelial cells; moderate amount of hyaline degeneration of the Malpighian bodies.

SUMMARY OF INTERESTING FEATURES IN THE FOREGOING CASE.

First, the long period of personal observation.

Second, the invasion of the disease, preceded by an infectious appendicitis.

Third, the intervals of perfect health, interrupted by profuse bleedings.

Fourth, the blood findings, which corresponded in every particular to Senator's description.

Fifth, the exacerbation of temperature and the accompanying leucocytosis, both indicative of some form of infection.

Sixth, the slate-colored stools and the diarrhœa, evidence of a digestive disturbance.

Seventh, the severe pains between the shoulder-blades, and the enormous quantities of morphine given necessary to relieve pain.

Eighth, the disappearance of the distended abdominal and chest veins, followed by the spontaneous disappearance of the ascites.

Ninth, the splenectomy followed by the rapid increase in the percentage of hæmoglobin.

Tenth, the appearance of the normoblasts and the megaloblasts in the blood subsequent to the splenectomy.

Eleventh, the rapid regeneration of a very abnormal blood.

Twelfth, the disappearance of the melanoderma following the operation.

Thirteenth, the thrombosis of the right innominate, subclavian and internal jugular veins, and the recovery of the patient from the same.

In conclusion, it might be said that Banti's disease forms a distinct chapter in the surgery of the spleen, and that it offers a favorable prognosis if operated early, death resulting if it is allowed to go unoperated, the gravity of the operation increasing " pari passu" with the size of the spleen.

I take this opportunity of expressing my sincerest appreciation to Dr. G. W. McCoy, of the United States Marine Hospital Service, for the splendid service he has rendered in the accurate observation of the blood in the above case.

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ON THE PATHOLOGY AND CLASSIFICATION OF INTUSSUSCEPTIONS, WITH A RÉSUMÉ OF THOSE ARISING FROM THE APPENDIX CÆCI.

BY EDRED M. CORNER, M.B., B.C., F.R.C.S.,

OF LONDON,

Assistant Surgeon to the Hospital for Sick Children, Great Ormond Street; Demonstrator of Anatomy at St. Thomas's Hospital; Erasmus Wilson Lecturer to the Royal College of Surgeons.

INTUSSUSCEPTIONS may be classified, firstly, into single, double, triple, etc. As almost every intussusception is regarded as single, the above divisions are frequently disregarded. But as it is my desire to draw attention to the great frequency of the occurrence of double intussusceptions, I wish to emphasize this method of classification. Of single intussusceptions, four kinds are said to be recognized, namely, enteric, *i.e.*, of small bowel only; ileocolic when small bowel is prolapsed through the ileocæcal valve; ileocæcal when the ileocæcal valve forms the leading part of the intussusceptum; colic when only large bowel is implicated. By ileocolic is meant that the invagination has begun in the ileum and then passed wholly or in part through the ileocæcal valve. This passage through the valve in no way constitutes a second intussusception any more than does the passage of an intussusceptum through another segment of the bowel. Therefore the word ileocolic should be strictly confined to this, and be merely understood to mean a subvariety of enteric intussusception; and a variety which must soon cease by the inability of more gut to become prolapsed through the valve, when a second and colic intussusception may become added.

That considerable difference of opinion exists as to the relative frequency of these different forms of intussusception is quite clear from the following statistics, derived from the general literature, St. Thomas's and St. Bartholomew's Hospitals.

VARIETY.

Author.	Enteric.	Ileocolic.	Ileocæcal.	Colic.	The Rest.
Treves*....	30 per cent.	8 per cent.	44 per cent.	9 per cent.	9 per cent.
Sargent†...	11 per cent.	5 per cent.	69 per cent.	5 per cent.	10 per cent.
Eccles‡	4 per cent.	2 per cent.	87 per cent.	5 per cent.	2 per cent.

It is noticeable that the chief variations in numbers exist among the enteric and ileocæcal varieties, and of itself suggests that there are some difficulties in the diagnosis and differentiation of these forms. The three sets of statistics agree in that the ileocæcal form is the most common, the ileocolic the most uncommon, and that over 90 per cent. of cases are examples of single intussusceptions. Such a state of affairs may be taken as representing the sum total of the present-day views.

Observations and Cases.—During 1901 and 1902 I operated on fourteen cases of intussusception, and from observations made on these cases it was borne in upon me that either I had struck on a most remarkable series or that there had been errors in the previous observations.

My first case found was the only one that I had diagnosed as ileocæcal, and, as subsequent observations made me examine my notes again carefully, I was compelled to put to myself the question as to why I had diagnosed the variety as ileocæcal at all; and found myself compelled to take up the following rather weak position. My reasons were, firstly, because on superficial examination the intussusception obviously started at the ileocæcal region; secondly, I had found something that felt like the valve per rectum; and, finally, and I am sorry to say not least, I had been taught that it was almost always safe to diagnose it on such grounds. In fact, there was no positive evidence at all that it was really ileocæcal. But in my notes I find that I observed also that the last half-inch or so of the ileum was very dark in color, and had to be reduced by traction on the small bowel. Hence I now believe my original diagnosis to have been erroneous, and that I was really dealing with a small

* Intestinal Obstruction.

† St. Thomas's Hospital Reports, 1900.

‡ St. Bartholomew's Hospital Reports, three papers.

enteric intussusception that had become impacted in the ileo-cæcal valve, and so had led to a second intussusception in which the cæcum passed into the colon. Thus, primarily, it was of the ileocolic subvariety of enteric, and subsequently became double by means of the addition of a colic intussusception to it, ileo-colic-colic. In three previous communications * I have not classed this case as a double intussusception, but on further consideration I have decided to do so now. Of my small series of fourteen cases no less than eleven were double. This gives a percentage of 80 approximately. The remaining three, or 20 per cent., were single and colic. This is a very remarkable state of affairs; and I have considered and reconsidered the matter, but feel so sure of my observations that it has been thought worth while to try and turn the attention of other observers to the point. I am fully conscious that, as Carlyle says, " Curious to think how, for every man, any the truest fact is modelled by the nature of the man. I said, The earnest man, speaking to his brother men, must always have stated what seemed to him a fact, a real appearance of Nature. But the way in which such an appearance or fact shaped itself, what sort of fact it became for him, was and is modified by his own laws of thinking; deep, subtle, but universal, ever operating laws. The World of Nature, for every man, is the Phantasy of Himself; this world is the multiplex Image of his own Dream." Therefore I abstain from making suggestions further than I have done, and give no results from my figures. But it will be stated later which form or forms of double intussusception are considered likely to be found the more common. The errors that seem to have arisen in connection with these cases may be traced mostly to the fact that the last one-half to one inch of the ileum has not been examined.

The ileocæcal variety is the one most frequently diagnosed wrongly. In fact, when examined, its diagnosis rests more on preconceived notions and absence of evidence that the case was really otherwise than upon any real positive fact that indicated

* St. Thomas's Hospital Reports, 1901, and Journal of Comparative Pathology, 1903–4. (Two papers.)

its true nature. "Ileocæcal" has been diagnosed over and over again in cases reduced by manipulation, inflation, injection of water, etc.; where there has been no post-mortem examination; times without number where a hastily reduced gut has been even more hastily replaced in the abdomen, when neither the reduction nor the reduced gut has been observed, and so forth. Such is the state of affairs, that any case diagnosed as ileocæcal requires more steadfast proof than one diagnosed as enteric or colic, because one feels that the latter is based on actual observation, and that the former is not.

Three cases of the series have been put down as single intussusceptions, and all three of the colic variety. But further consideration has led me to believe that one of these that began in the outer pouch of the cæcum was double, and that it arose in this way. The inversion of the outer pouch of the cæcum was followed by that of the caput coli, which then blocked the ileocæcal valve, and so caused a secondary invagination of the ileocæcal variety to be superimposed. The double intussusception would be called colic-ileocæcal. Unfortunately, I did not know of or recognize the possibility of this variety at the time when the operation was performed.* If this case were accepted as a double intussusception, the percentage would rise from 80 to 87!

All of the cæcum which lies below the level of the ileocæcal valve, *i.e.*, the caput coli and the appendix, if invaginated, are very prone to be complicated by the addition of a second invagination of the ileocæcal variety, colic-ileocæcal. This form of invagination is doubtless much more common than is thought, but is not so frequent as that in which trouble begins in the lower part of the ileum.†

The three examples of single intussusception that passed under my notice were of the colic variety,—one started in the cæcum, one in the ascending colon along with a sarcoma, and one in the transverse colon.

* Nor in the paper in the St. Thomas's Hospital Reports, 1901.

† The above is the case if the ascending colon lies passive. But if it is active by its peristalsis, it may add a colic intussusception. The double might be colic-colic. Or it might be triple colic-colic-ileocæcal.

SUGGESTED TABLE OF THE VARIETIES OF INTUSSUSCEPTION.

Variety.	Probable Frequency.	Definition.
Single.		
1. Enteric.	Uncommon.	Small gut into small gut.
2. Ileocolic.	Rare by itself.	Enteric through valve.
3. Ileocæcal.	Uncommon.	Originates at the valve.
4. Colic.	Probably the most common single intussusception.	Large gut into large gut.
Double.		
1. Double enteric.	Rare.	Enteric into small gut.
2. Ileocolic-colic.	Most common of all intussusceptions.	Ileocolic "impacted" in valve, the cæcum invaginated into colon.
3. Enteric-ileocolic.	Very rare.	Double enteric, with one part prolapsed through valve.
4. Enteric-ileocæcal.	Second most frequent variety.	Enteric pushing valve in front of it.
5. Ileocæcal-colic.	Very rare.	Ileocæcal and cæcum into colon.
6. Double colic.	Rare.	Colic into large gut.
7. Colic-ileocæcal.	Fairly common.	Caput coli of cæcum invaginated first, and blocks the valve, causing ileocæcal intussusception.

Note the distinction between an ileocæcal-colic and a colic-ileocæcal intussusception, the primary invagination is put first.

The above table indicates that it seems likely that double intussusceptions may prove to be more common than single; that the ileocolic-colic form is the most common; the colic-ileocæcal or the enteric-ileocæcal next in frequency, and that true ileocæcal forms by themselves are rare. In making up the names, I have adopted the simple expedient of building up the compound names in such a way that they contain and explain the total structure of the double intussusception. Hence, as soon as one becomes familiar with the names, all become simple.

The time is scarcely ripe to consider triple or more complicated intussusceptions. But the double variety, doubtless very rare, enteric-ileocolic, *i.e.*, a subvariety of double enteric, is the

one most likely to form a triple intussusception, enteric-ileocolic-colic. Or the double enteric may take on an ileocæcal form, *i.e.*, enteric-enteric-ileocæcal.*

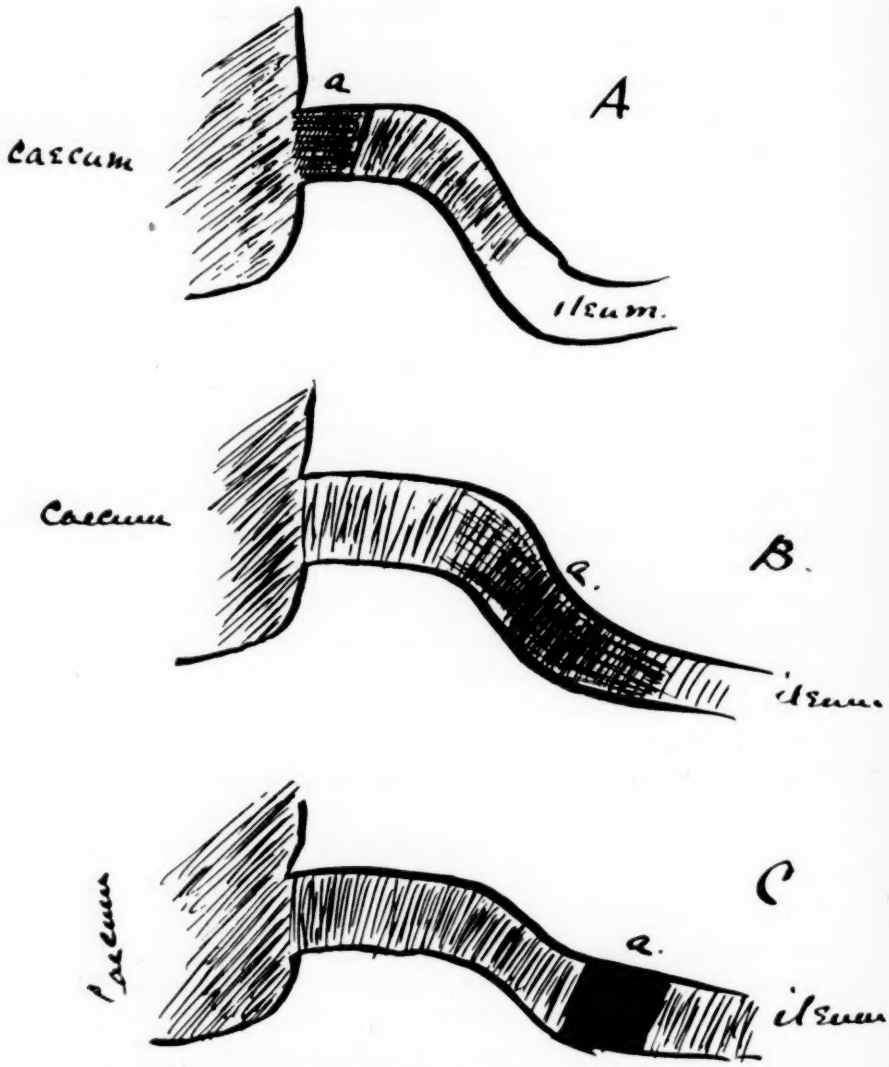
The Diagnosis.—On looking down the list of double intussusceptions, it will be seen that the greatest difficulty in diagnosis will be between the ileocolic-colic and the enteric-ileocæcal forms.

The Reduction.—When once the reduction of an invagination is started, it proceeds easily enough, and if opportunity occurs, it can be seen that much gut is reduced before any small bowel is expressed from the cæcum. This suggests that in reality only a little small bowel may have been engaged, and that the reduction so far has merely been that of the colic part of a double intussusception. If the form was merely ileocæcal, this simple reduction might continue to the end; but it is almost a platitude that the final part of the reduction of an intussusception gives most trouble. If an intussusception is first reduced in part by inflation per rectum, it is this small enteric intussusception that has been left unreduced. This combined method of treatment by inflation and operation has been much practised at the Hospital for Sick Children, Great Ormond Street, London, and has some advantages over an immediate unaided laparotomy. The inflation reduces the colic part, and leaves the enteric to be reduced by operation, which procedure must never be omitted.

About this time the small intestine will begin to be expressed from the cæcum; the final reduction may take place suddenly, and a small enteric intussusception be expelled from the cæcum as though shot out from an ileocæcal fossa. Or traction on the small bowel may be necessary, and if combined with expression and used carefully, it will be frequently noticed that the last half-inch of the ileum is withdrawn from the ileocæcal valve. Or after reduction, a lateral dimple is noticeable

* The rare chronic intussusception associated with Meckel's diverticulum is probably the most common triple or quadruple invagination in practice.

FIG. 1.



A. Invagination began in the ileum close to the cæcum, and the small enteric intussusception is easily overlooked. In *B* and *C* the invagination began farther from the cæcum, and in each there would be a definite enteric intussusception. In *C*, the apex of the primary intussusception was strangulated in the jaws of the ileocæcal valve, and the shaded part, *a*, is not strictly definite. In *B* the valve was pushed in front of the intussusceptum, and *a*, the point of origin of the involution, has gradations of discoloration on either side. *Varieties.*—*A* was ileocolic-colic; *B*, enteric-ileocæcal; *C*, ileocolic-colic. *A* is the most common form.

in the last half-inch or so of the ileum. The last appearance certainly suggests that the invagination started in this lateral dimple and led to the engagement of the terminal portion of the ileum in the ileocæcal valve.

After Reduction.—The most important part to examine is the termination of the small bowel. It may be noticed that the last half-inch is frequently observed to be sharply defined from the contiguous bowel by its deeper or even black color; also by being frequently not œdematous and without adhesions. The obvious inference is that this part has been strangulated in the ileocæcal valve, and this may have been rendered certain by previous observations made during the reduction. In other cases, which do not seem to be so common and in which a small enteric intussusception can always be seen when the reduction is done carefully, a gradation of color is noticed reaching a maximum at a variable distance up the small gut above the cæcum, and at the place where the invagination arose. It is by no means easy to decide whether the apex of the intussusceptum of this enteric invagination has gone through the valve or not. If the gradation of discoloration is similar on both sides of the place where the infolding originated, and there are no sharp lines of demarcation on either side, it may be inferred that the intussusceptum pushed the ileocæcal valve in front of it. On the other hand, if the discoloration of the primarily invaginated spot is sharply defined, it probably passed through the valve. Careful observation during the time of reduction may help one to form an opinion. Again, the higher that the enteric intussusception arises above the valve the more likely is its intussusceptum to have become œdematous, and so be unable to pass through. Consequently, the valve will be pushed on in front of the original intussusception, and the second invagination will be of the ileocæcal variety.

It is doubtful if the time or the condition of the appearance, during reduction, of the appendix helps much, though the venous return from that organ would appear to be most interfered with when the ileum just above the ileocæcal valve is engaged in it.

TABLE OF THE DIFFERENCES BETWEEN THE ILEOCOLIC-COLIC AND THE ENTERIC-ILEOCÆCAL INTUSSUSCEPTIONS.

Ileocolic-colic.	Enteric-ileocæcal.
1. Last part difficult to reduce if at all large, and very likely reduced suddenly.	Easy to reduce, and reduction may be smooth.
2. Traction very likely necessary.	Traction usually unnecessary.
3. Probably no enteric intussusception seen.	Enteric intussusception probably seen.
4. Bowel most discolored near the cæcum.	Bowel most discolored distant from cæcum.
5. Origin close to cæcum.	Origin probably more than two inches from cæcum.
6. Lateral dimple in ileum near its termination.	This not seen.
7. Discoloration of gut sharply defined.	Discoloration in gradation, and due to traction on the mesentery.

As will be seen, it may be quite impossible to decide to which class the intussusception really belongs, as they merge one into the other.

Evolution of an Invagination (Fig. 2).—The distinction between these two varieties may be an easy or may be a most vexed question. A very interesting complication may now be considered. If an intussusception begins two, three, or more inches above the ileum, the intussusceptum passes in part through the valve; but it is very variable as to how much, or all, of the invagination may pass through. The whole does sometimes pass through, and in doing so unrolls itself. The ring which marks the site of the invagination on the ileum may be gradually pulled down until it coincides with the margins of the ileocæcal valve. Inside the cæcum the enteric intussusception has consequently undone itself. This has come at least once under my observation, and a case reported for other reasons by Macfadyean in a horse, in the *Journal of Comparative Pathology,* April, 1903, shows a similar tendency. This is believed to be more common than may be supposed, and in itself, or its approximation, constitutes the greatest obstacle to

reduction by expression alone. And the enteric intussusception itself cannot be observed when the bowel is expelled from the cæcum.

FIG. 2.

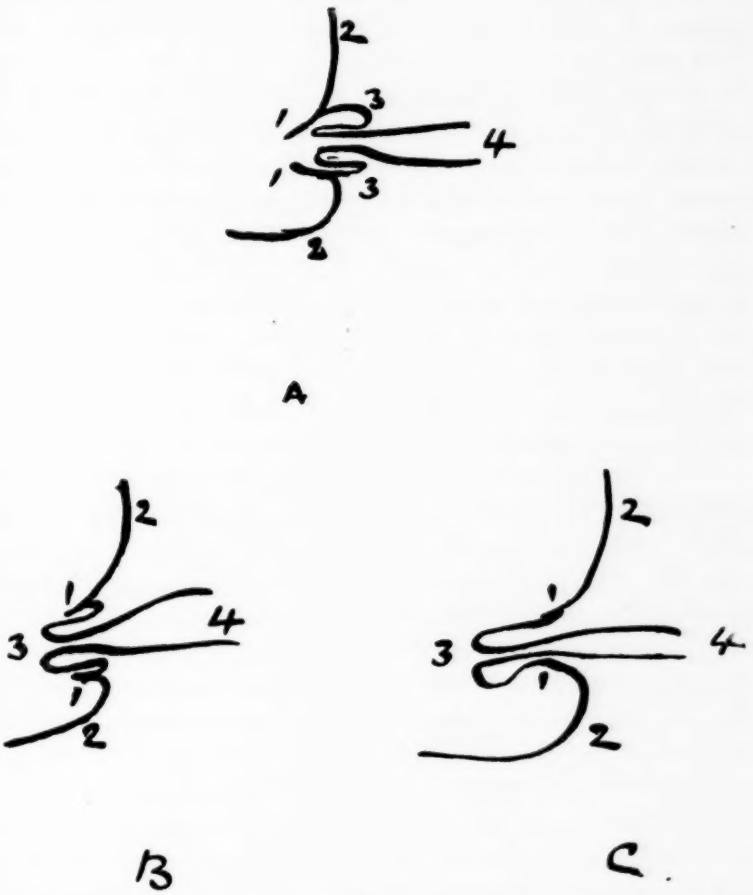


Diagram showing how an enteric intussusception may unroll itself at the ileocæcal valve in its different stages. *A* being the start of the invagination and *C* its final evolution. 1. The ileocæcal valve; 2. walls of cæcum; 3. the intussusception; 4. the ileum. In *C* the unrolling or evolution is complete.

In invaginations that begin in the last inch of the ileum, probably the most common site at which one originates, the phenomenon of unrolling or evolution is almost the normal state of affairs, and in itself is a great obstacle to reduction

expression alone. It may render the use of traction necessary for its final reduction.

It seems hardly necessary to mention, and so condemn, the diagnosis of the presence of the ileocæcal valve in the rectum by reason of the finger-tip. The apex of any intussusceptum will give a similar impression.

Pathological Remarks.—It is well known that intestinal obstruction occurring in the small intestine causes more acute symptoms than when the large is involved. But this statement certainly requires modification, because a number of purely enteric intussusceptions are more or less subacute or chronic; and it seems that the predominating factor is rather the completeness or incompleteness of the obstruction. Purely enteric intussusceptions are always short, and consequently the intussusceptum may be little œdematous, and the obstruction therefore incomplete. This has certainly been the case with two enteric intussusceptions that I have had the opportunity of examining after their excision. In both cases the lumen of the bowel was pervious to water. Again, as will be emphasized later on, the invagination may arise from the side of the bowel and not from a circular constriction. This will also aid in keeping the intestinal canal patent.

The most common place by far for intussusception to arise is in the last inch or so of the ileum; and it is here that the lateral dimple on the wall of the bowel can be most frequently seen after the reduction. Except in the case of polyps and the like, intussusceptions have been chiefly thought to arise in a circular contraction of the bowel aided by "irregular peristalsis," whatever that may mean. Nothnagel's classical experiments, quoted by Treves in his "Intestinal Obstruction," have done much to render this view fixed. But from the cases observed it seems that a lateral and not a circular origin is the most common.

It is a striking fact that the ileum is the situation in which invaginations are the most common, and more especially so in the last inch of it. It is difficult to see why the ileum should be more affected than the jejunum. The chief anatomical dif-

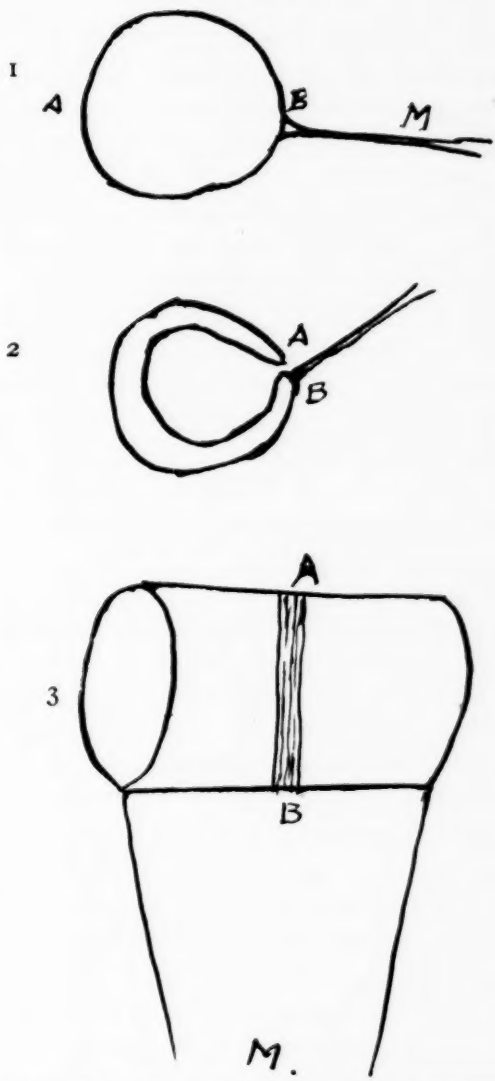
ferences being that in the former the walls are thinner and more pliable, and that lymphoid nodules and patches become more and more frequent as the ileocæcal valve is approached. Another point is the increasing viscosity of the intestinal contents. Also the ileum is becoming more fixed as it approaches the cæcum. Experience gained at operations undoubtedly represents that of experiments on man. Every surgeon must have opened the abdomen of a case or cases which have been diagnosed as obstruction, peritonitis, etc., and found that most interesting condition in which alternate segments of the bowels are contracted and dilated with no other lesion. Such a condition must be related to colic, and similarly there will be a relation between colic and intussusception. I have had such an experience more than once, and have tried pushing the contracted bowel into the dilated to see if I could produce anything like an intussusception. Nothing of the kind happened, and very probably due to the anæsthesia, as it is a matter of common observation that during operations it is not common to observe peristalsis. The production of an intussusception requires active and not passive intestines. One thing is certain with regard to the etiology of this subject, and that is, the association of intussusceptions with improper feeding is infinitely more common than the casual hospital note would lead one to believe. The mothers are naturally frightened, and do not tell the truth for fear of giving the notion that they are responsible in any way for their infants' distressful condition. But if inquiries are made carefully, it will be found that the onset of the pain began shortly after the child had eaten a piece of hard biscuit, or the like. The babies do not often show the condition of chronic gastro-enteritis and wasting, but are quite fat and healthy. Hence it appears that the intussusception is more dependent on the occasional indiscretion of diet than upon the customary. We know little or nothing of the pathology of colic or stomach ache, and it is probable that the above-mentioned clinical observation is of importance, and its association, *i.e.*, of the segments of collapsed and dilated bowel, with an undigested bolus may furnish the requisite physical conditions for

the production of an intussusception, the collapsed part being well pushed home into the dilated by the contraction excited by the undigested food. The invagination having been once started, it requires regular peristalsis to retain it; and if colic is "irregular peristalsis," it is just as likely to undo the intussusception as to keep it inverted. It seems reasonable to associate the formation of invaginations of the bowel with the "colicky" condition that has been found on the operating table. And as enteric intussusceptions are known to be short, and that every now and then cases are found which prove that intussusceptions may spontaneously reduce, it seems almost an act of philosophic faith to believe that enteric intussusceptions are of frequent occurrence, but that it is practically only when they involve the ileocæcal valve that they become urgent. In the last half-inch of the ileum the lateral wall of the gut becomes inverted and engages in the ileocæcal valve, which then contracts spasmodically upon it, and there is complete obstruction. A condition like this forcibly reminds one of prolapsed piles and the spasmodic contraction of the sphincter ani. A sacculus of the cæcum or colon inverted by the more solid fæces seems to be at the root of colic intussusceptions. The subject of primary ileocæcal intussusceptions will be left until the veterinary cases have been considered.

An interesting pathological point may be mentioned here, namely, how an intussusception travels to the anus, or even out of it. The greater part of the distance by far is accomplished by the stretching of the bowel wall, mesentery, etc. The presence of a second intussusception will also very likely help.

Before closing this section of the paper, I would like to refer to occasional bands that are found in these cases extending from the mesenteric attachment of the ileum, just above the cæcum, to its opposite border. I have been unable to form any sure idea on their origin and significance, but would suggest that they mark the site of a lateral invagination. The dimpling and the traction exerted by peristalsis will bring the two opposite borders in contact (2). The adhesion so formed will appear as a band when the bowel is reduced (3).

FIG. 3.



1. A loop of bowel with its mesentery, *M*. 2. The same loop laterally invaginated; the peristalsis pulls on the intussusceptum and approximates the borders of the gut, *A* and *B*. 3. Segment of ileum from an intussusception with the bowel reduced. The adhesion formed in 2 shows as a band, *A*, *B*.

Evidence of the Veterinary Record.—It is now our custom to turn to the lower animals for explanations of the problems of our own structure, functions, and pathology in the shape of experimentation, immunization, etc. But it has not been the custom to refer our morbid anatomy to them. As I applied a similar test to the influence of position in fractures and dislocations, in the *Lancet* of 1898, so has it been attempted to do the same with regard to the origin of intussusceptions. The results of my inquiry from a veterinary point of view have been published in the *Journal of Comparative Pathology* for 1903. In all, I found records of some forty cases, and in not a single one was the ileocæcal valve the originating point of the intussusception. It is most common in dogs, and, like man, begins in the small intestine, though apparently higher above the valve than in his case. Twenty-nine cases were described with sufficient anatomical detail to enable me with certainty to diagnose the varieties:

Nine cases were purely enteric.

Twelve cases were ileocolic.

Eight cases were colic.

Therefore, in twenty-one cases the invagination began in the small gut, and in eight in the large; in no case was the ileocæcal valve primarily concerned. The views founded on observations on mankind have been confirmed. With regard to the frequency of double intussusception in animals, it has not been always possible from the descriptions to decide. Four were certainly double, whilst as many as ten or twelve more may have been.

It is interesting to note that both clinically and experimentally (D'Arcy Power) cats seem immune or tolerant of intussusceptions.

The Ileocæcal Valve in Chronic and Acute Cases.—In conclusion, it may be pointed out that whilst in acute cases it seems probable that the inversion starts in the ileum and not at the ileocæcal valve, as then the obstruction is complete from the first. In chronic cases such as I have seen others, for example,

Mr. Makins and Mr. Battle, operate on, it does seem that the intussusception arises at the ileocæcal valve, probably by its being incompletely blocked.* As a result of the *vis a tergo* of the peristalsis of the small intestines, the valve is propelled into the cæcum, and slowly the inverted peritoneal surfaces contract adhesions or, as seems more probable, the inverted part becomes thickened and more or less irreducible. This state of affairs, the intestinal canal being patent, may go on for a long while, until finally a more acute exacerbation leads to its occlusion, and the case comes under observation.

It is interesting to consider the possible and perhaps probable position that intussusceptions of the ileocæcal type occupy. As primary invaginations, they are probably uncommon, especially so in acute cases. Among chronic intussusceptions they will be more frequent. As secondary intussusceptions they may be imposed upon an enteric, most commonly, or a colic which begins in the caput coli or the appendix. It may be found to exist more frequently in the secondary than in the primary form.

Invaginations in the lower end of the small intestine and in the large below, and about, the level of the ileocæcal valve are very likely to become double.

Treatment by Inflation, etc.—If the views that have been suggested here are right, they shed a very bright light upon the dangers and deceits of the treatment by inflation alone. In acute cases, beginning in the last half-inch of the ileum, it will probably be necessary to stretch the cæcum sufficiently to dilate the ileocæcal valve in order to release the ileum. And, unfortunately, the direction of the phlanges of the valve is such that the more the cæcum is distended the tighter is the valve closed. It also shows that, though the tumor may disappear through the reduction of the colic parts of the intussusception, the ileum may remain fixed in the jaws of the ileocæcal valve, and be quite

* It is, however, not clear that these invaginations have not originated in the caput coli.

undiagnosable without laparotomy. Operation, therefore, is the only intelligible method of treatment.

At the Hospital for Sick Children, Great Ormond Street, a practice has been made of beginning the reduction by inflation and finishing it by operation. In this way it has been found that the inflation reduces in suitable cases all but the invaginated small bowel, *i.e.*, the colic part, whilst it has left unreduced the enteric or, better, ileocolic. The difficulty in the reduction of this last part by inflation or expression is due to two reasons, firstly, the evolution of its invagination, and secondly, the spasm of the muscles of the valve.

Note on Museum Specimens.—When the stated frequency of ileocæcal intussusceptions is taken into account, one is very much struck by their comparative rarity among museum specimens. All the other varieties of intussusception are well represented. At the present day the opportunities of adding to the museum examples of invaginations of the gut are becoming fewer and fewer. And for knowledge of the anatomy it is necessary to rely more upon the surgeon than upon the pathologist. The natural result is that, with regard to the special subject under consideration, the museum series cannot in any way be regarded as representing the sum total of our knowledge. Moreover, criticism may be offered to the terms and descriptions there used.

Firstly, with regard to specimens labelled ileocæcal, only in a few cases have these been thoroughly examined, and, as a general rule, the diagnosis seemed to be based on superficial observation founded upon preconceived ideas. In many specimens the openings of the valve and the appendix are very clearly shown, and I would like to attract attention to the fact that in some cases the valve is in advance of the appendicular orifice, and sometimes *vice versa*. And it would appear that the latter cases have really started in the caput coli and not at the valve, being really colic, of a cæcal subvariety, and not ileocæcal.

Again, a further fact strikes the observer in that, in a very

large proportion (if not almost all) of these so-called ileocæcal cases, the valve is not closed, but open and patent in varying degree! It is apparently inconceivable that an open valve can be primarily responsible for the invagination unless blocked by some bolus of undigested food. It therefore seems probable that in most of these cases we must look for a further cause. And from observations at the time of operation I would suggest that it will be found in the last one-half to one inch of the ileum. Most museums have one or more specimens with the ileum still projecting through the valve. As was seen in many instances at the operation, many invaginations arose as a lateral dimple in the last inch or so of the ileum, and that this became engaged in the jaws of the valve, very much as a pile or prolapse may be grasped by the sphincter ani. The second colic intussusception will result from this blocking of the valve. But after death or excision the tonic contraction of the valve will relax, releasing the little invagination of the ileum, which may retreat or become smaller as the œdema fluid flows away, coagulation and contraction follows, etc. Hence there are reasons why this small gut protrusion may be absent in museum specimens.

One thing remains perfectly clear, and that is that by far the best and most satisfactory way to investigate the anatomy of an intussusception is to reduce one in the living subject or one just excised. Of course, formalin preparations would be satisfactory, but there is little opportunity. And in the absence of these, especially of the reduction, the *fons et origo mali* has never been observed, and the diagnosis must be received with caution.

It may be suggested that the hitherto called ileocæcal class will be resolved into those which start in the lower end of the ileum, in the cæcum, and a few that start at the valve itself. An invagination, therefore, commonly begins on one or other side of the ileocæcal valve, but rarely at it. Almost all museums neglect the existence of the more exact, if academic, division of intussusceptions into single, double, etc.

SUMMARY OF THE PRINCIPAL POINTS.

Reason has been found to suggest that

(1) Double intussusceptions are more common than single.

(2) Ileocolic-colic intussusceptions are the most common of all; enteric-ileocæcal or colic-ileocæcal next.

(3) The single ileocæcal variety is decidedly uncommon and found principally, or nearly entirely, in chronic cases.

(4) The ileocolic is the most common variety of primary intussusception.

(5) The inversion begins laterally and most frequently in the last part of the ileum, which becomes engaged in the jaws of the ileocæcal valve.

(6) The so-called ileocæcal forms probably arose in the last half-inch of the ileum or the caput coli.

(7) The evolution of the enteric invagination at the ileocæcal valve constitutes the chief difficulty in the reduction of the last part of the invagination, frequently rendering traction necessary.

(8) That both in man and animals the ileocæcal valve is practically never primarily responsible for the trouble.

INTUSSUSCEPTIONS ASSOCIATED WITH INVERSION OF THE VERMIFORM APPENDIX.

By intussusception of the appendix is generally understood its inversion into the cæcum, which event is followed by the invagination of that structure into the ascending colon. Such an event is undoubtedly rare; but, as the majority of the cases have been recorded during the last few years, it may be safely prophesied that they are by no means so uncommon as has hitherto been supposed. A careful examination of the literature has led to the discovery of the reports of sixteen cases. In all of these the inversion was complete, and there was no scrap of evidence to show its pathogenesis. Fortune then led me to

a paper by Dr. Rolleston, of St. George's Hospital, London, in which he described a case of prolapse of the mucous membrane of the appendix into the cæcum. It was found at a post-mortem examination of the body of a woman aged thirty-two, who had died of peritonitis secondary to the perforation of a duodenal ulcer. The prolapse was obviously caused by the peristaltic action of the appendix excited by the presence of a concretion.

FIG. 4.

Heavy line, mucous membrane; fine line, peritoneum; *A*, appendix; *B*, fæcal concretion covered by mucous membrane projecting into the cæcum; *C*, cæcum.

The value and significance of this case have not been realized. It is the only adequately recorded case of partial inversion of the appendix into the cæcum, and so gives the key to the explanation of those cases of total inversion of the appendix associated with invagination of the caput coli. Up to this date, the subject had merely been one of speculation. Mr. D'Arcy Power, of London, has referred to a similar case in a discussion.

The small size of its lumen and the relatively great thickness of its walls preclude the invagination of the appendix into itself. Arguing from Rolleston's case, the invagination may be according to the presence of a concretion, a mass of secretion, a swollen lymphoid follicle, or the like, which is protruded

into the cæcum by the muscular action of the appendix behind it. The appendix forms the intussusceptum and the cæcum the intussuscipiens. This variety differs from all the others in that, owing to the large size of the cæcum (the intussuscipiens), it cannot contract closely enough to grasp and still further invaginate the appendix (or intussusceptum). The inversion is entirely due to *vis a tergo* on the part of the appendix, and *vis a fronte* is practically lacking. In such a way as this the appendix may be turned inside out. It is difficult to see how mere prolapse of the mucous membrane into the cæcum can progress farther, owing to the inability of the cæcum to grasp it and pull. Viewed in this light, Dr. Rolleston's paper is a most valuable contribution to the pathology of the cases under discussion.

The conditions produced by the inverted appendix into the cæcum may be likened to that produced by a long uvula in the pharynx. Both cæcum and pharynx are excited to swallowing movements, which, in the case of the former, cause the caput coli to be drawn up into the cæcum. If it is drawn up sufficiently far to obstruct the ileocæcal valve for an appreciable time, an attack of abdominal pain is experienced by the patient. But unless the caput coli is borne well above the valve, the cæcum seems unable to seize it and drag it onward, and the colic passes away, the valve becoming unblocked again owing to the recession of the caput coli and appendix. As these attacks succeed each other, the recession becomes less and less perfect, due to the chronic inflammatory changes and the formation of adhesions, until at last the ascending colon grasps the intussusceptum and superimposes an acute or subacute colic intussusception, aided by the *vis a tergo* of the small intestines. Clinically, these cases are very chronic, and at operation or post-mortem it is impossible to reduce the intussuscepted mass.

These cases are examples of double intussusceptions associated with the appendix. The primary invagination consists of the appendix followed by that of the caput coli. Later, a secondary colic form is superimposed on account of the primary

invagination blocking the ileocæcal valve.* Seventeen cases have been recorded, and every one of them was chronic, giving a history of a long period during which the patient was subject to colicky pains, vomiting, etc. Twelve occurred in males, four in females; all were chronic; sixteen occurred in children between the years of two and a half and nine; one occurred in a woman of forty-two. Eleven recovered, six died. In eight the gut was resected, of which six recovered; in five it was reduced, with four recoveries; in three the condition was found post-mortem.

It is extremely interesting to note that in no case had the inversion caused the appendix to slough. In this position the blood stream is not of necessity stopped, and it may not be seriously interfered with. And, again, the inverted position so alters things that the appendix no longer offers a culture tube like lumen for the nurture of organisms. Wallace, whose original paper I have been unable to consult, records a case of the passage of an appendix in a stool, but whether this was inverted or merely from an appendix abscess, cannot be said.

One further remark may be made. All, except one, of these cases occurred at an age before that at which appendicitis is common, and in no case was there a history of previous inflammations of that organ. In point of fact, appendicitis will very likely leave behind it such fibrosis, stricture, adhesions, etc., that it may be regarded as protective against inversion. The chronic catarrhal appendicitis that leads to the formation of concretions may be an exception to this.

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* It is not very clear whether this secondary invagination will be colic, as here stated, or ileocæcal. If the colon remains passive, the *vis a tergo* of the small intestines will push the valve onward, an ileocæcal invagination resulting. But if the colon actively contracts on the inverted caput coli, it will become invaginated itself, and the secondary invagination will be colic.

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INTUSSUSCEPTIONS ASSOCIATED WITH MECKEL'S DIVERTICULUM.

Intestinal invaginations associated with the persistence of the vitelline duct (Meckel's diverticulum) form rather an abstruse subject. But as triple and quadruple intussusceptions are found along with them, it has been thought that this paper might suitably follow in this connection. The nomenclature and classification of intussusceptions are essentially of pathological and academic interest, and the extreme rarity of the cases at present under consideration hardly gives the subject any practical bearing.

A short summary of the conclusions is given at the end of the paper.

Intussusceptions of Meckel's diverticulum are rare events and are of great interest. The all-important condition of Meckel's diverticulum in order for it to be invaginated is that it must be free from all adhesions. In the majority of the recorded instances of the presence of this diverticulum, it has been associated with some adhesions. Hence, it seems that by the results of its own pathological changes it becomes immune to invagination. Intussusceptions of this diverticulum may occur in a variety of ways, which may be broadly separated into those associated with patency at the umbilicus and those in which it is only connected with the ileum, its other end being free. The former class will be considered first.

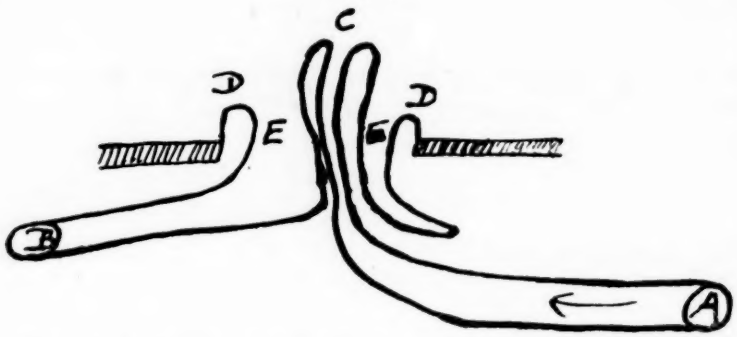
I.—Intussusceptions associated with a Meckel's diverticulum opening at the umbilicus.

(A) An invagination may form in the small bowel above the origin of the diverticulum, then descend and traverse its lumen so that the intussusceptum may become prolapsed at the umbilicus. This form of invagination is really a very complex one, being almost always associated with prolapse of the diverticulum itself, which surrounds the prolapsed intussusceptum like a collar (Figs. 5 and 6). The tumors formed in this way at the umbilicus are difficult to recognize. Fæces will only come from the apex of the central mass, the intussusceptum, and not from the groove around it. No fæces will be passed per rectum after one or two motions. This need not be a very rapidly fatal variety of intussusception; for as long as the lumen of the intussusceptum is patent the condition is really one of anus prenaturalis. The child wastes and dies if unrelieved. The pathological condition can be best understood by means of the following diagram.

Mr. Golding Bird, of London, has reported one of the most interesting of these cases in the Clinical Society's Transactions, 1896, xxix, p. 32. A male child, aged four weeks, was brought to Guy's Hospital with a fæcal fistula. On examination it was found to have a tumor at its umbilicus, from the summit of

which fæces were escaping. No fæcal matter was extruded from the groove round the base of the tumor. Ultimately the baby died.

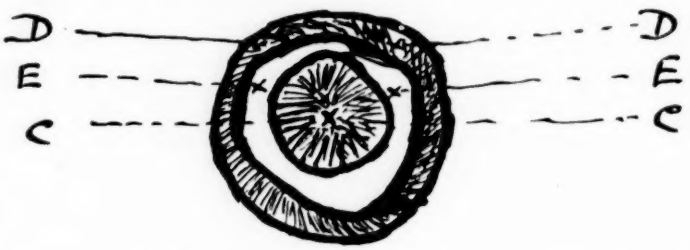
FIG. 5.



Diagrammatic section through the umbilicus. *A* is the small gut above the diverticulum, *B* is the small bowel below the diverticulum, *C* is the apex of the intussusceptum (the central mass), *D* is the prolapsed collar formed by the patent diverticulum, *E* is the groove between the intussusceptum and its collar.

(B) The next class of cases is where the posterior wall of the bowel opposite the communication between Meckel's diverticulum and the ileum becomes protruded through the umbilicus (Fig. 7, *X*). Such a condition may be brought about in two ways.

FIG. 6.



Bird's-eye view of umbilicus. Lettering as in Fig. 5. *C* is the intussusceptum, *D* is the collar of prolapsed diverticulum, and *E* is the intervening groove.

1. The process begins with prolapse of the patent Meckel's diverticulum through the umbilicus, starting with the part immediately next the navel. By these means the ileum is pulled

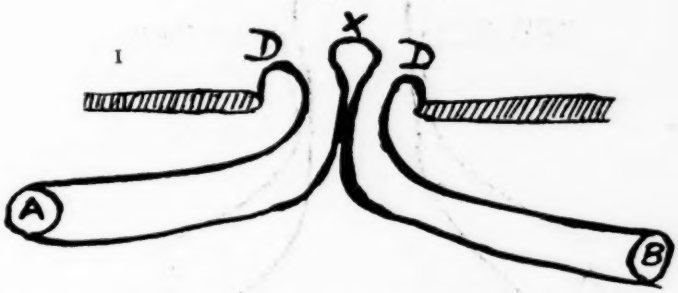
up to the umbilicus (Fig. 7), and its posterior wall, marked *X*, dragged on, so that it engaged in the bowel prolapsed at the

FIG. 7.

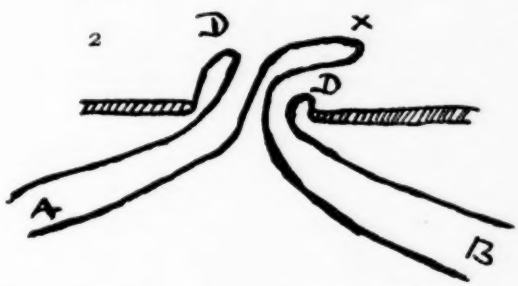
Prolapse of Meckel's diverticulum. Lettering as in Fig. 5. *A* is bowel above the diverticulum; *B*, that below; *D*, the prolapsed diverticulum.

umbilicus (Fig. 8). The invagination only occurs at the umbilicus after the whole of the diverticulum is prolapsed. It is therefore the result of the prolapse.

FIG. 8.



Intussusception of bowel through a prolapsed Meckel's diverticulum. Lettering as before.



Further development of Fig. 8, 1. Lettering the same, and note the similarity, Fig. 9, 4.

If the process continues, and more bowel is passed out the umbilicus, the intussusception is further increased. This is a unique variety, and differs from the greater degrees of prolapse of rectum in that the part marked *X* is the intussusceptum, and

FIG. 9.

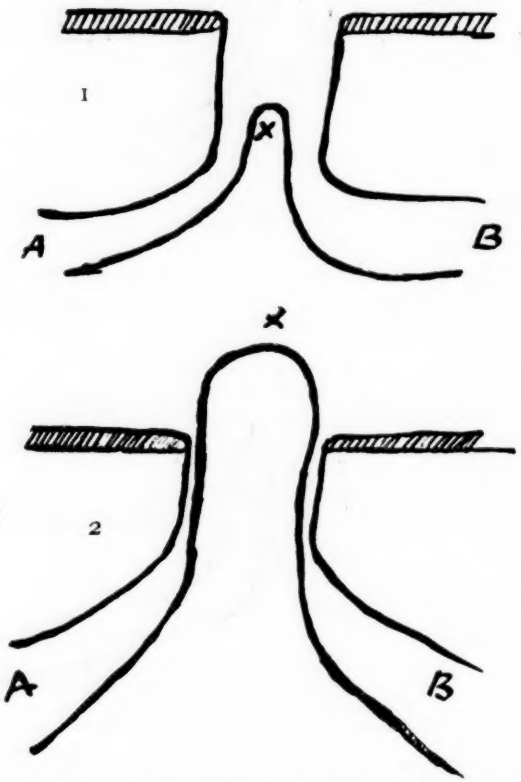
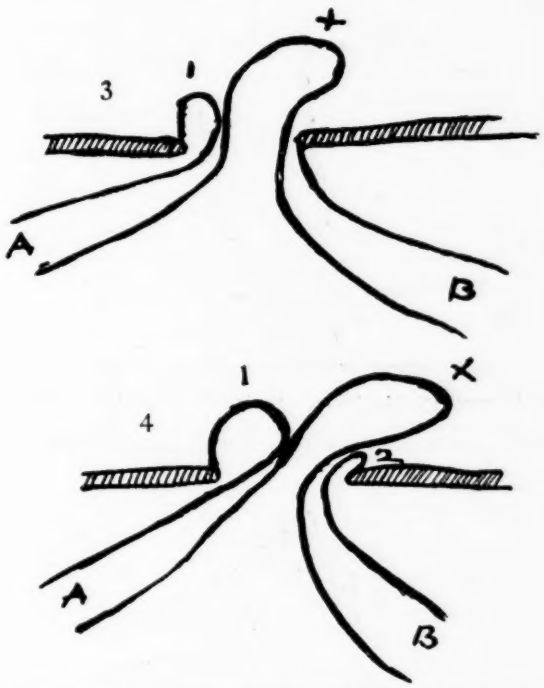


Diagram illustrating the intussusception of the posterior wall of the ileum at the place where the diverticulum joins it (1, *X*). In 2 the intussusceptum is passed out of the umbilicus. *A* is the bowel above, and *B* that below, the junction of the diverticulum; *X* marks the prolapsed intussusceptum.

the already prolapsed walls, *D*, represent the intussuscipiens. In prolapse of rectum there is no intussuscipiens, and therefore there can be no intussusception in the true and logical meaning of the word. The intussusceptum in this case differs from that of the ordinary intussusception in that it is derived from one

side of a strip of bowel and not from a circular or oval infolding.

2. In this division, the posterior wall of the ileum opposite the internal opening of Meckel's diverticulum, owing to some bend or kink, gets caught by the diverticulum, whose peristalsis passes it out at the umbilicus.



Further stages of Fig. 9. In 3 the part of the walls of the diverticulum next to the bowel above has been prolapsed, 1. This is soon followed by that of the opposite wall of the diverticulum, 4, 2. Note the asymmetry of the collar surrounding the intussusceptum, *X*.

In these cases the diverticulum need not be prolapsed at all. A tumor projects from the umbilicus having no aperture on its apex, and fæces come from the groove around it. Nothing will be passed per anum. This protrusion, if the child lives, tends to become polypoid, and has been ligatured and cut away. It represents the spur, or éperon, in a colostomy, and may be treated similarly. There is considerable importance in recog-

nizing this class of case. Owing to the fact that little or none of the diverticulum is prolapsed, there is little or no collar round the central tumor.

(C) One of what I believe to be a common way in which the diverticulum becomes invaginated is that the intussusception starts in the diverticulum itself, and practically always at the

FIG. 10.

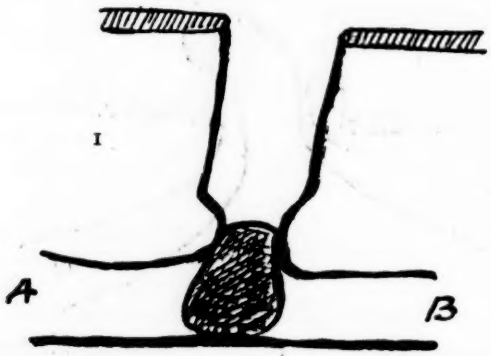
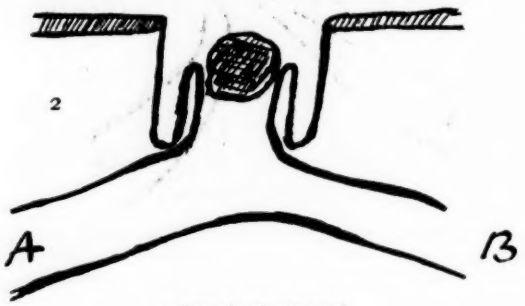


Diagram of intussusception beginning at the junction of the diverticulum and the ileum Lettering as before.

1. Formation of invagination with suggested bolus of undigested food.



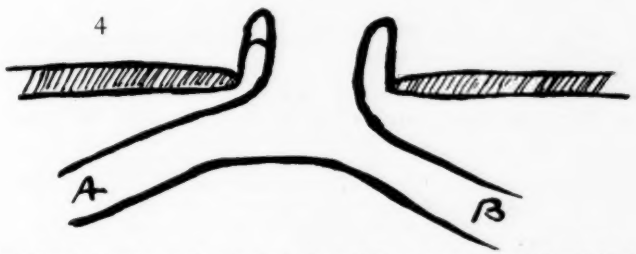
2. Invagination formed.

point where it joins the ileum. The start of the invagination is some undigested or improperly digested bolus, which is seized by the internal opening of the diverticulum, and at the same time thrust onward by the contraction of the ileum.

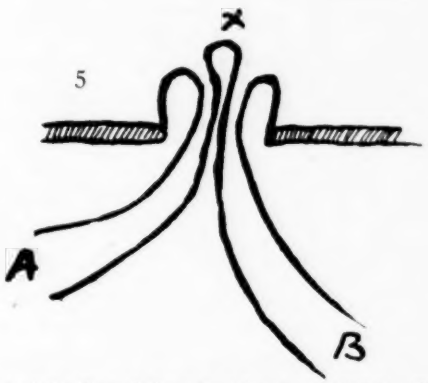
The invagination is formed at the most internal part of the diverticulum and pushed by the contraction of the ileum into the

tube (Fig. 10, 1 and 2). The intussusception thus formed is extruded at the umbilicus, and in so doing undoes the invagination (Fig. 10, 3 and 4). Then the ileum itself may be protruded from the navel (Fig. 10, 5).

3. Invagination passing through the umbilicus.



4. The invagination has in passing through the umbilicus become everted, and is simply a prolapse of the diverticulum.



5. The posterior part of the ileum is invaginated and extruded from the umbilicus. Note asymmetry of collar. See Fig. 8, 2, and Fig. 9, 4.

The clinical appearance in the final stages of this last class is similar to that which was just described as resulting from primary prolapse of the diverticulum (Figs. 7 and 8). In it,

as a rule, the intestinal obstruction is most complete, and clinically the pathological process may stop at any of the stages, particularly (Fig. 9, parts 2 and 3) if the case becomes acute. If the stage of Fig. 9, parts 4 and 5, is reached, the obstruction is relieved and the case becomes more chronic.

It is a matter of considerable probability that some of the cases reported as prolapse of Meckel's diverticulum are not really cases of intussusception without acute obstruction. (Such as Löwenstein, Langenbeck's *Archiv für klinische Chirurgie*, 1895, xlix, 541–563.)

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FIG. 11.

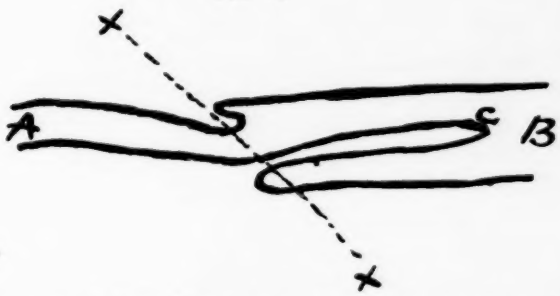
Inverted diverticulum. *A* is the bowel above, and *B* that below, the inverted diverticulum *C*. In the diagram the structures are represented uncollapsed.

II.—Intussusceptions of a Meckel's diverticulum which is only attached to the bowel.

This is the more common developmental defect than that of the patent fistulous tract at the umbilicus. The diverticulum is found in more than 2 per cent. of bodies. Most commonly it is a hollow process, two or three inches long, attached to the free border of the ileum about thirty inches above the ileocæcal valve. Its situation on the ileum is, however, subject to many variations. The invagination practically always begins at the free tip of the process, which becomes completely inverted into the ileum. This is not so frequent as might have been expected, probably because the majority of cases in which the presence of the diverticulum is recorded it has been adherent.

The inverted diverticulum irritates the surrounding bowel, which by peristalsis pushes and pulls it onward, so dragging in the bowel wall to which it is attached. But, as the origin of the invagination is lateral, the ring where the bowel is infolded is very oblique, and consequently the intestinal lumen is not completely occluded, and the case may be clinically subacute (Fig. 12).

FIG. 12.



Showing the invagination that begins unilaterally, and *X*, *X*, shows the obliquity of the ring where the bowel is infolded. *A*, *B*, and *C*, as in Fig. 11.

This is a very interesting pathological fact, and explains why some of the recorded cases give long subacute histories, and in which an adherent inverted process is found at the bottom of a recent acute invagination. It is impossible to say how many of the reported cases come under this explanation, as the pathological descriptions do not always allow of an opinion being formed.

In other cases the intussusception is acute, and I believe is brought about in the following way. The inverted process is grasped by the ileum in a way similar to the contraction which is known to occur on a gall-stone, and the obstruction is complete.

The result of this block is that the whole is pushed on into the small bowel below, and a secondary enteric invagination is added.

This may travel as far as the ileocæcal valve, which it may then either go through wholly or in part, or it may push the valve in front of it. The first is called an ileocolic intussuscep-

tion, and the second ileocæcal. Travers admirably describes an ileocolic case.

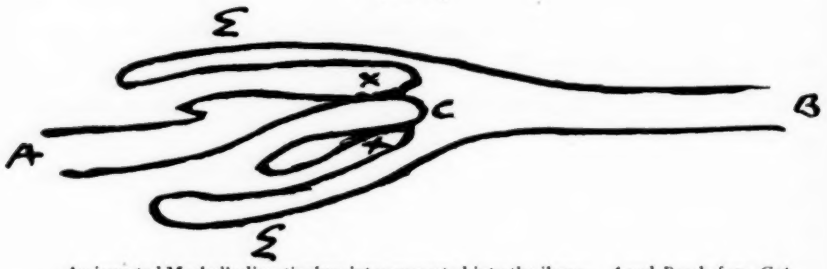
When the various invaginations are considered anatomically, they are found to be very complex. To begin with, there is the intussusception and inversion of the diverticulum itself.

FIG. 13.

Illustrating the inversion of the diverticulum (*C* at its tip), which is grasped by contraction of the small bowel at *X*, *X*. Dotted line indicates the obliquity of the ring of the infolding of the bowel. For clearness, the inverted process is not represented as compressed. *A* and *B* as before.

In acute cases this is grasped by the small bowel, and second invagination of the enteric form is added by the propulsive power of the small intestines. In chronic cases by bowel is secondarily invaginated by the traction of peristalsis on the

FIG. 14.



An inverted Meckel's diverticulum intussuscepted into the ileum. *A* and *B* as before, *C* at the tip of the inverted process, *X*, *X*, at the points where this is grasped by the ileum, and *E*, *E*, are the layers of the secondary intussusception.

inverted process. Thus clinically and pathologically these two types may be seen. In some cases these two enteric invaginations may be present together, when that formed by traction behind the inverted process is small. Thus it is seen that two types exist.

1. A double intussusception of chronic cases, *i.e.*, traction.

2. A double intussusception of acute cases, *i.e.*, propulsion.

3. A triple intussusception of cases, especially where an acute attack is imposed on a chronic, and both traction and propulsion enteric intussusceptions may be present together.

When this compound intussusception reaches the ileocæcal valve, one and two may remain double intussusceptions, the enteric part becoming ileocolic, *i.e.*, passing through the valve. Or they may push the valve forward and become triple by the addition of an ileocæcal intussusception. In the third case similar changes may occur to that just described. That is, it may remain triple by part becoming ileocolic, or it may become quadruple by the addition of an ileocæcal invagination.

For the nomenclature of these cases, the following may be suggested.

x 1. Diverticulum-enteric (chronic).

x 2. Enteric-diverticulum (acute).

* 3. Enteric-diverticulum-enteric. (Typically acute or chronic.)

At the ileocæcal valve.

x 1. Diverticulum-ileocolic.

x 2. Ileocolic-diverticulum.

* 3. Ileocolic-diverticulum-enteric.

Or,

* 1. Diverticulum-enteric-ileocæcal.

* 2. Enteric-diverticulum-ileocæcal.

‡ 3. Enteric-diverticulum-enteric-ileocæcal.

As in all ileocolic forms, the valve may become impacted and a further colic variety of invagination formed. Thus the above may become

* 1. Diverticulum-ileocolic-colic.

* 2. Ileocolic-diverticulum-colic.

‡ 3. Ileocolic-diverticulum-enteric-colic.

Those marked x are double intussusceptions, those * are triple, and those ‡ are quadruple. Intussusceptions associated

with an inverted diverticulum constitute the most common forms of triple and quadruple intussusceptions.

Sixteen cases of this second great class of intussusception associated with the inversion of a Meckel's diverticulum have been recorded. Most of them were fatal and most of them were acute. Two most successful and more chronic cases are recorded by Travers and Zum Busch. Some, usually the chronic, occurred in adults; but this second class is found in older subjects than those with the diverticulum patent at the navel.

SUMMARY.

Intussusceptions associated with Meckel's diverticulum fall into two groups.

I. When the process opens at the umbilicus as well as into the small intestine.

II. When it is only in connection with the intestine. This is the larger group.

I. The first group may be subdivided as follows:

(A) An enteric intussusception formed above the process, traverses it, and is extruded at the umbilicus. Figs. 5 and 6.

(B) The ileum opposite the internal opening of the diverticulum becomes protruded at the umbilicus.

α. As a result of prolapses of the diverticulum. Figs. 7 and 8.

β. Primary extrusion of this part of the ileum. Fig. 9.

(C) The intussusception begins in the diverticulum itself. Fig. 10.

II. The inversion of the diverticulum in *acute* cases is associated with an enteric intussusception, the gut grasping the process is forced onward, propulsion. Figs. 13 and 14.

In *chronic,* the inverted process inverts the ileum behind it by dragging, traction. Fig. 12.

In acute attacks on a chronic, both these traction and propulsion enteric invaginations may be present. Fig. 14.

The most common triple and quadruple intussusceptions are associated with the inversion of this process.

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THE DIAGNOSIS AND TREATMENT OF ACUTE PANCREATITIS.*

BY GEORGE WOOLSEY, M.D.,

OF NEW YORK,

Professor of Anatomy and Clinical Surgery, Cornell University Medical College; Surgeon to Bellevue Hospital; Associate Surgeon to the Presbyterian Hospital.

By acute pancreatitis I intend to include those cases of pancreatitis beginning suddenly and severely, usually but not always accompanied by pancreatic hæmorrhage, and often associated after a few hours with fat necrosis. If the patient lives long enough and the disease progresses, necrosis of the pancreas and local or general suppuration, one or both, may occur. In other words, acute pancreatitis is taken to be an acute affection of the pancreas, probably inflammatory, beginning suddenly and acutely and manifesting itself in one or more forms. The patients may die in collapse in the first few hours, or they may survive the stage of collapse to run the gauntlet of necrosis or suppuration of the pancreas or diffuse peritoneal suppuration. In some cases the disease appears to be arrested in the early stages, either spontaneously or as the result of treatment, so that at the outset it may be admitted that a spontaneous cure is possible; but this seldom, if ever, occurs except in the milder cases beginning less acutely, and in these cases the diagnosis is only a probable one when unconfirmed by operation or autopsy.

In the following remarks, I refer only to the severe forms of acute pancreatitis.

I may illustrate such cases by a summary of three cases I have operated upon, at the same time indicating the treatment to be recommended. As these cases have been already reported in the Medical and Surgical Reports of the Presbyterian Hospital, 1902, page 47,† I will merely give a brief *résumé*.

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* Read before the New York Surgical Society, May 27, 1903.

† Also reprinted in the Medical News, December 20, 1902.

CASE I.—Female, single, aged twenty-four years. Typhoid seven years ago. Two years ago, several attacks of cramp-like epigastric pain and vomiting for several hours. Present illness began three days ago with severe cramp-like epigastric pain. Vomiting since second day. Constipation in spite of cathartics. After twenty-four hours, pain most severe in right iliac region. Patient looks septic and very sick. Abdomen somewhat distended, rigid and tender, especially in right lower quadrant. No mass palpable. Diagnosis, diffuse septic peritonitis, probably from appendicitis. Operation on day of admission, three days after onset. Appendix exposed and found normal. Considerable dark brown fluid in peritoneal cavity. Gall-bladder exposed and found somewhat distended and adherent. Escape of similar dark fluid. Areas of fat necrosis in small and great omentum. Pancreas felt to be much enlarged and hard. Fluid evacuated. Gauze drainage. Suture. Fifteen hundred cubic centimetres saline infusion for collapse. Patient very sick for two days, bowels moved on third day. Left hospital in nineteen days, with two small sinuses. Leucocytosis on day of operation, 39,000. Microscopically, sediment of peritoneal fluid looks like decomposed blood.

CASE II.—Male, married, aged thirty-two years. Alcoholic. Several attacks of colic; severe attacks one year, four months, and five days ago; pain occasionally radiates to shoulder. Present illness began in the early morning of day operated on, with violent cramps and vomiting. Catharsis effective. Patient looks sick and septic. Abdomen slightly distended, rigid, and tender, especially in epigastrium and hypochondria, more particularly on right. No mass palpable. Marked collapse. Diagnosis, possible acute pancreatitis, Case I having been operated on five days before. Operation about twelve hours after onset. Three-inch median incision above umbilicus, pancreas hard and enlarged, especially the head. Slightly turbid serum evacuated; otherwise nothing abnormal. No fat necrosis seen. Gauze drainage. Pulse feeble and rapid; temperature high for first four days. On removing drainage after forty-eight hours, considerable reddish-brown fluid escaped. Discharged cured in nineteen days. Leucocytosis 17,600 before operation. Fluid in peritoneal cavity gives reaction of pancreatic secretion, and shows under the microscope large cocci, evidently non-pathogenic.

CASE III.—Male, married, aged twenty-nine years. Alco-

holic. Attacks of indigestion after drinking. On day of admission to medical ward, vomiting and sharp pain in epigastrium. Abdomen tender, rigid, and distended. Bowels regular, stools dark brown, no free fat. Urine, 1050 sp. gr., twenty-eight grains of sugar to the ounce the first day, a trace the second day, and none subsequently. I saw him in consultation on the second, third, and fourth days of the disease. Diagnosis, acute pancreatitis, from symptoms, mode of onset, and glycosuria. Operation advised. Improvement for a time, but ten days after onset, leucocytosis 26,000, and signs of diffuse septic peritonitis. Operation eleven days after onset. Median incisions, one above and one below umbilicus. Large quantity of foul, purulent serum evacuated. Thorough irrigation. Separation of overlying adherent intestines, closing pelvis, opened an encapsulated pelvic abscess in which appendix was found swollen, but not apparently diseased. Pancreas felt very firm, hard, and enlarged, but collapsed condition did not allow its exposure. Gauze drainage through upper and lower wounds. For four or five days he was in desperate condition, but then improved. He then had profuse diarrhœa and emaciated rapidly at first, but later recovered some weight. Fluid from abdominal cavity showed streptococci, but not of the most virulent form. Discharged from the hospital in forty-one days.

The first two cases were operated on in the early stages, the first on the third day and the second twelve hours after the onset. The first case was hæmorrhagic, and showed fat necrosis; the second case showed no fat necrosis or bloody fluid, but the latter appeared on removing gauze drain after two days, and it may have been too early for fat necrosis. The last case showed marked early but temporary glycosuria. Bacteriologically, the fluid in the last case showed streptococci, in the second case large cocci, and in the first case no mention of bacteriological examination is noted in the history.

For the purpose of diagnosis, severe acute pancreatitis presents quite a characteristic picture; so much so, that Hahn [1] says that to make a probable diagnosis lies mostly in the realm of possibility. It occurs mostly in men of middle life (forty to sixty years, Hahn). It begins suddenly, with intense epi-

gastric, colicky pain, later becoming general, severe vomiting and eructations, and distention of the abdomen, especially in the upper part. There is rigidity and tenderness of the abdomen on pressure, with singultus. Marked collapse occurs and the face and extremities are cold, often cyanotic, and covered with a cold sweat. The temperature is low, often subnormal; the pulse is small and rapid (120–160). Death occurs in nearly all severe cases within four or five days.

In addition, the diagnosis is made more probable if this group of symptoms occurs under conditions in which acute hæmorrhagic pancreatitis is most often found, *i.e.*, in connection with corpulence, alcoholism, gall-stones, gastroduodenal catarrh, traumatism, and arteriosclerosis. Alcoholism was marked in two of my cases and is often noted; it probably predisposes to pancreatitis by causing gastroduodenal catarrh. The association of acute pancreatitis with gall-stone disease was clearly shown by Opie, especially in the case of a stone obstructing the papilla, and many cases are now reported where this association with cholelithiasis was noted. In many such cases of obstruction of the common duct pus can be pressed out of the pancreatic duct (Robson). Mr. Robson [2] says that the causes of disease of the pancreas are the same as those of the gall-bladder. Although in the latter an infection from the duodenum is more often observed, it is not clear why the pancreas should be so often free from the invasion of the infection, unless it be due to what Truhart [3] calls the exquisite bactericidal property of the pancreatic secretion. Robson adds that there are three ways of infection: (1) from the organs in contact; (2) from the blood; (3) from the duct; and he thinks the latter is the more common. It is here assumed that the disease is an infection; and I think that this is the case; cultures taken from the affected pancreas post-mortem almost always show micro-organisms, mostly bacillus coli commune, and in two of my cases the peritoneal exudate showed cocci. Experimentally this view is abundantly upheld. Yet some still look upon pancreatitis as a non-inflammatory affection, notably Truhart [3] in his recent work on the

pancreas. The relation of trauma to hæmorrhagic pancreatitis is illustrated by experimental observations and several reported cases,[4] which also indicate that the fat necrosis is the result and not the cause of the inflammation. The pancreatitis may occur soon after the trauma or not until after months or a year. The escape of the pancreatic secretion into the peritoneal cavity after trauma gives rise to fat necrosis and the symptoms and signs of acute pancreatitis.

The two conditions from which a differential diagnosis is most often required are intestinal obstruction, high up, and peritonitis from a perforated gastric or duodenal ulcer.

While acute pancreatitis and obstruction from the pressure of the swollen pancreas may coexist, as pointed out by Robson, this probably rarely occurs. The distention in pancreatitis is usually less general and pronounced than in intestinal obstruction; the obstruction less complete,—so that flatus may often be passed and repeated enemas may sometimes relieve it,—the pulse is more rapid, the temperature more apt to be slightly elevated; there is often a history of previous attacks of colic, the vomiting is not apt to become stercoraceous, and leucocytosis is more pronounced. If in addition the disease comes on very acutely with collapse, and if one or more of the predisposing conditions exist, the diagnosis can often, if not usually, be made. It is true, however, that many cases of acute pancreatitis have been operated upon early for intestinal obstruction. In such cases the presence of fat necrosis is almost pathognomonic of pancreatitis.

In perforation of a gastric or duodenal ulcer, premonitory symptoms of the disease will usually have been present, including pain on eating, hæmatemesis or black stools, and anæmia. The tenderness and rigidity are present but less marked, while the absence of liver-dulness, from early intestinal paresis, occurs almost at once. In phlegmonous cholecystitis and gangrenous appendicitis the location of the early tenderness is usually sufficient for diagnosis. But "as the only diseases which acute pancreatitis is likely to simulate are such as can only be relieved by surgical treatment, if we can

prove that operation is beneficial in this class of cases, we shall have established the advisability of operating in all cases of peritonitis starting in the upper half of the abdomen." [5]

A point I would like to emphasize is the following:

The diagnosis of severe cases of acute pancreatitis, with the typical picture already given, is easier than that of the less acute cases or the subacute; Hahn [1] says the suppurative forms appear milder, less severe, and less fatal. Last summer I saw two such cases of pancreatitis with local suppuration, and in neither did I make the diagnosis, though I was on the lookout for acute pancreatitis. One of these cases, seen a month or more after the onset of the attack, was reported by Dr. F. Tilden Brown before this Society last winter, and presented symptoms and a tumor which suggested an affection of the kidney. The other presented symptoms of general peritoneal sepsis in addition to a uterine fibroid.

There are a few other factors which may assist in the diagnosis of pancreatitis, but more especially of the less acute forms. Glycosuria is rare in the experience of Robson and in the series of reported cases. In this connection one point is to be noted. Flexner [6] found in experimental pancreatitis that glycosuria appears early (thirty minutes the earliest) and disappears after a few days, even in lasting alterations of the pancreas. In Case III, the only one of my cases in which it was found, it was present only during the first two days, and in large percentage only on the first day. If, then, we are to look for glycosuria, it is probable that it will be found mostly in the first days of the attack, and then only in a small percentage of cases, but perhaps a larger percentage than has been supposed. Free fat and undigested muscle-fibres in the stools are two other signs to be looked for in a certain number of cases. According to Fitz,[7] the former occurs only or mostly when there is associated liver disturbance. In twenty-nine cases where free fat was found, jaundice was present in only twelve and glycosuria in only eleven cases. Jaundice and glycosuria were seldom present at the same time. In eight cases where undigested muscle-fibre was found, there was glycosuria

in six, free fat in five, and jaundice in only two. Robson considers fat in the stools more common than glycosuria. In diagnosis, Fitz's rule is to be borne in mind: Acute pancreatitis is to be suspected when a previously healthy person or a sufferer from occasional attacks of indigestion is suddenly seized with violent pain in the epigastrium, followed by vomiting and collapse, and in the course of twenty-four hours by a circumscribed swelling, tympanitic or resistant, with slight rise of temperature. In the acute stage the tumor cannot be palpated without an anæsthetic, on account of the tenderness and rigidity.

Treatment.—Hahn [1] says that most cases of the severe form of acute pancreatitis die within four or five days. Many indeed die in the first twenty-four hours. Some pass on into the later stages of the process and develop general peritonitis or local abscess with or without necrosis of the pancreas. In a very few cases the process seems to become arrested. The question arises, Have we any means to favor this arrest of the process? I think we have in *early incision,* thereby confirming the diagnosis, evacuating the fluid, and establishing drainage.

It has been commonly advised hitherto to delay operation until the symptoms of collapse have passed off. This means leaving many cases to die unaided. Experience has shown that we have no better means of overcoming the collapse than an evacuation of the septic peritoneal exudate and an intravenous infusion, provided the operation is not prolonged. All this may be done under cocaine anæsthesia. The argument is also advanced that the percentage of mortality after operation is less if we wait for a local abscess to form. This was the position taken by Bloodgood in a paper read before the New York State Medical Society at Albany in January, 1902, based on reported cases alone. The argument appears to me to be entirely fallacious. In the first place, it takes no consideration of the large percentage that die in waiting for such a favorable occasion. In the second place, many, such as my three cases, never develop a local abscess, but the process is diffuse from the outset. In the third place, a similar argument might with

equal propriety have been advanced against the early operation for appendicitis in the early days of the operation. From statistics, it might then have been said that it was safer to open a perityphlitic abscess than operate on the inflamed appendix through the peritoneum, without taking into account the number that died of peritonitis without the formation of a perityphlitic abscess.

We may admit with Körte [8] that the prognosis in cases of necrosis or local abscess of the pancreas is better the later the operation becomes necessary. If they do get over the symptoms of obstruction and collapse and go on to local abscess, the prognosis is so much the better; but it is not safe, and therefore not wise, to wait for this possibility in the severe acute cases.

But what are the results of early operation? This has most often been undertaken to relieve the supposed obstruction of the bowels, for which the pancreatitis was mistaken. Most of the cases have died; a few recoveries have been reported. We must admit with Körte that almost all the cases, and this is characteristic, taken for intestinal obstruction and operated on as such have died, for the patients are collapsed and unable to stand the prolonged operation of search for the obstruction.

The proper procedure, in my opinion, is that employed in the three cases I have cited, which is essentially like that strongly advocated by Hahn.[1] The latter, in view of the ease of a probable diagnosis, advises against the commonly practised and recommended symptomatic and expectant treatment and in favor of a small median incision. If through this the presence of fat necrosis is established, further operation is to be avoided except for evacuation of the peritoneal fluid and drainage. If no fat necrosis is present, then the small intestine is to be searched for obstruction. Before this is done, however, I would advise palpation of the pancreas, or even its inspection through an opening in the gastrocolic ligament. Every extensive operation is to be rejected in such collapsed patients.

Without making a complete review of recent literature, I

have found several successful cases reported which were operated on in this way. Hahn reports one, and another case of bullet wound of the pancreas; P. Leusden [9] another, Halsted one, Cases I and II make two more, and Bevan, of Chicago, in a personal communication to me, reports two cases of incision, evacuation, and suture without drainage. Mayo [10] reports another case where in addition he removed a large gall-stone. Halsted's case is peculiar in this, that the patient later developed the same symptoms, and recovered under his observation without operation; so that it can hardly be classed with the cases whose results strongly favor this plan of treatment. We must admit that the operation affords no security against recurrence, for we cannot do a radical operation, as in appendicitis, from the very nature of the case. Hahn's case, on the other hand, was considered moribund. He reports three similar cases ending fatally where the operation was more prolonged and extensive.

How does this simple operation cure the condition? As Körte says, to bring about a cure by this operation, the process in the pancreas must not overstep a certain stage,—that is, the operation must be done early, and the process must stand still and not advance after the operation. In my cases I did nothing more because the collapsed condition of the patients would not allow it. I fully expected to have to operate later for an abscess or necrosis of the pancreas, perhaps exposing the latter as Robson has advised in the costovertebral angle. To my surprise, not only the patients recovered but required nothing further. It must be that the evacuation and drainage, with or without irrigation, arrested the progress of the pancreatitis by removing the septic fluid, which, if left, leads to general or local peritonitis, or by relieving the tension, and thereby the congestion. Robson,[2] speaking of the treatment of this condition, says that, as in gangrenous appendicitis, so in this equally lethal affection, an early exploration is demanded in order to evacuate the septic material and adopt free drainage. If an irreparable condition has already been reached in the pancreas, then the necrosis will proceed and pus form;

but at least we gain time, and by the operation we can bring the patient into the second stage or to a cure. In my third case eleven days elapsed between the onset of the attack and the operation, and yet the pancreatitis resolved, showing that a cure can sometimes be expected from the same simple means after a considerable interval. As before indicated, the operation may readily be done, if desired, under local anæsthesia.

If, then, by a simple operation in the acute stage, if desirable under cocaine anæsthesia, we can both combat the collapse and cure the condition, the operation not only may be, but should be, done.

In conclusion. 1. In the severe acute cases of pancreatitis, the symptom complex, in connection with some predisposing factor or factors, and perhaps some other early signs, renders it possible to make a probable diagnosis.

2. The diagnosis is easier than in the less acute cases.

3. It is only likely to be mistaken for conditions which also require early operation.

4. The finding of fat necrosis at the operation confirms the diagnosis.

5. The treatment should consist of early operation, including infusion for collapse, evacuation, and drainage. This may be done under local anæsthesia.

6. Extensive or prolonged operations are not justifiable.

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IDIOPATHIC DILATATION OF THE COLON.

BY R. W. MURRAY, F.R.C.S.,

OF LIVERPOOL,

Surgeon, David Lewis Northern Hospital.

CHRONIC dilatation of the colon is a condition not uncommonly met with in adult life, and is generally due to some definite mechanical obstruction, such as stricture of the gut or fæcal impaction, the result of habitual constipation.

The case I am about to relate, however, is of an entirely different character, in that it occurred in a young child, and the dilatation of the colon was not due to mechanical obstruction.

The history of the case is briefly as follows:

The patient, a boy now four years of age, had suffered from constipation and abdominal distention since birth, constantly requiring aperients or enemata. On one occasion, when five months old, his bowels were not opened for several days, and his abdomen became greatly distended, but repeated enemata finally relieved him. When eleven months old he had another and more serious attack of constipation with distention; this attack lasted on and off for five weeks. He also occasionally suffered from attacks of diarrhœa. Since the child was eighteen months of age the abdomen has always been distended, and attacks of obstinate constipation with excessive abdominal distention very frequent. He has repeatedly gone as long as a week without an action of the bowels, and on one occasion there was no action for thirteen days. It is a noteworthy fact that the stools have never been scybalous, the fæces being always in a semi-liquid state, and, strange to say, the child's general health had not suffered to any great extent.

I first saw the child in April, 1901. He was then two years old and under the care of Dr. Roughan, of Formby. At that time there was a painless enlargement of the abdomen, and I regarded the case as one of tuberculous peritonitis. I saw the child again three months later, and, as the abdominal condition

was worse rather than better, and there was now evidence of fluid in the peritoneal cavity, I advised an operation.

In July, 1901, I made a small incision in the middle line of the abdomen below the umbilicus and some clear fluid escaped, but not a sufficient quantity to make any very appreciable difference in the abdominal girth, I inserted my finger through the wound and stirred up the intestines, as I generally do when operating for tuberculous peritonitis, but the incision being small I did not obtain any view of the abdominal viscera.

The immediate result of the operation appeared satisfactory, and I regarded the case as one of a cure following abdominal section of tuberculous peritonitis.

However, the mother brought the child to see me again fifteen months later, namely, in October of last year, and then told me that no real benefit had resulted from the operation, for, shortly after the child had returned home, the abdomen again became distended, and lately he had suffered more than ever before from constipation and attacks of extreme distention, the abdominal girth sometimes measuring as much as thirty-nine and one-half inches. The child was now little more than three years of age, and at that time of life twenty inches would be a fair allowance for the abdominal girth, so thirty-nine and one-half inches represented an extreme degree of distention.

I now thought very seriously of the child's condition, not that he appeared ill in himself or was suffering pain, but on account of the appearance of the abdomen; it was not only greatly distended, but the waves of peristalsis were more marked than I ever remember to have seen before, pointing obviously to chronic intestinal obstruction. As I still regarded the case as one of tuberculous peritonitis, I felt sure that the distention was due to obstruction from adhesion or kinking of the gut. Repeated enemata brought away a quantity of liquid fæces, and somewhat relieved the distention, so the presumed obstruction was not complete; but the abdomen soon became again distended and the peristalsis marked. The child took his nourishment fairly well and there was no vomiting. As two and one-half pints of the fluid could be injected per rectum and retained, it was obvious that the large bowel was not constricted, and I came to the conclusion that the point of obstruction was at the lower part of the small intestine, though, of course, the marked peri-

stalsis pointed to the large bowel being the seat of the trouble. The anus was certainly not narrowed, for it readily admitted one's index-finger, and this without causing the child pain or producing any spasm of the sphincter. The rectum was unduly capacious. As repeated injections afforded no relief, I decided to operate, and in October of last year, fifteen months after the first operation, I again opened the abdomen below the umbilicus, and at once came in contact with an enormously distended something, that I could not in the least make out what it was, and which filled the greater part of the abdominal cavity. On farther enlarging my incision, I succeeded in delivering this large tumor, which obviously contained air. I soon realized that my original diagnosis of tuberculous peritonitis was completely wrong, and that I had to deal with a case of extreme dilatation of the colon. My colleague, Mr. Monsarrat, who was present at the operation, kindly passed a rectal speculum for me, and I then readily emptied the distended colon of its gas and fluid fæces. When the colon was thus reduced to a manageable size, it was easily and clearly seen that the whole of the large bowel was distended from the cæcum to the anus, but the part chiefly involved was the sigmoid flexure and the descending colon; the bowel here measured six inches in diameter when distended and four inches when emptied. The small intestines presented a perfectly normal appearance. The emptied bowel was easily returned into the abdomen, which was now flat. As the result of our manipulations, the child's condition was not of the best, and, having completely relieved the distention and knowing now exactly what I had to deal with, I thought it better to postpone for the time being any further operation, and more carefully consider what could be done in the hope of effecting a permanent cure. I therefore closed the abdominal wound. This was the first case of the kind I had ever met with, and in thinking the matter over several methods of procedure suggested themselves. For instance, I might perform a colotomy, and so afford the distended bowel a period of rest, and thus give it an opportunity of recovering its tone; colonplication might be performed, or the large bowel might be short-circuited by effecting a junction between the ascending colon and the rectum.

What I actually did on December 16 of last year was to completely excise that portion of the bowel corresponding to the

sigmoid flexure and descending colon, and attach the transverse colon to the upper part of the rectum end to end by means of simple suture. The operation was a somewhat difficult one, as the cut ends of the colon and rectum did not correspond in size, both were considerably dilated, especially the colon end, which was much the larger of the two. However, the child made an exceptionally good recovery, has greatly improved in health since the operation, and does not now suffer from constipation or from abdominal distention.

What I particularly wish to draw attention to is the fact that in this case the distention of the colon was not due to any such mechanical obstruction as stenosis of the rectum or of the anus; on the contrary, it was clearly demonstrated that the rectum was considerably distended and the anus unduly patulous. A few years ago, Sir Frederick Treves recorded a case, entitled idiopathic dilatation of the colon occurring in a child, in which he successfully excised not only the distended descending colon and sigmoid, but also that part of the bowel corresponding to the rectum, which was represented by a solid-looking though pervious tube eight or nine inches long and about the size of an adult forefinger; and Sir Frederick Treves maintains that all cases of so-called idiopathic dilatation of the colon "in young children are due to congenital defects in the terminal part of the bowel, and that there is in these cases an actual mechanical obstruction, and that the dilatation of the bowel is not idiopathic."

A review of recorded cases, however, shows that there are two distinct varieties of infantile dilatation at the colon. In one the dilatation is due to congenital stenosis of the rectum, such as Sir Frederick Treves has described, and in the other, as in my case, there is no such mechanical obstruction, there being some congenital defect in the structure or nerve supply of the colon itself, the muscular coats of which are so defective in tone that they are unable to exercise sufficient force to expel liquid fæces or even accumulated gases, and in consequence become enormously distended.

An examination of the portion of bowel removed showed

that dilatation had taken place greatly in excess of hypertrophy, in fact, the wall of the gut was little, if any, thicker than normal.

Having made a mistake in the diagnosis, and being, I hope, wiser after the event, I would say there should be no real difficulty in arriving at a correct diagnosis if proper attention is paid to the previous history of the patient, and to certain clinical symptoms characteristic of the affection, which I have already mentioned. As to the treatment, in view of the complete success following excision of the distended portion of the gut in both varieties of infantile dilatation of the colon, I would suggest that this is the proper treatment for the affection.

A CONTRIBUTION TO THE STUDY OF INTESTINAL SUTURE, WITH A NEW METHOD OF INTESTINAL UNION.

BY J. SHELTON HORSLEY, M.D.,

OF RICHMOND, VA.,

Professor of Principles of Surgery in the Medical College of Virginia; Surgeon to Memorial Hospital.

In spite of the various and contradictory reports of experimenters in the field of intestinal surgery, there are three principles generally accepted by almost every surgeon: (1) Serous surfaces must be in contact; (2) if sutures are used, they must include at least a portion of the submucous layer; (3) the most desirable method of intestinal union is one that is safe, can be quickly done by a surgeon of average skill, and that requires no special mechanical appliance. Other points, such as the penetration of all intestinal coats, the use of a continuous or an interrupted suture, are still moot questions, and it will be my endeavor to contribute towards their settlement.

F. G. Connell has very ably championed the cause of the suture that penetrates all the intestinal coats with the knot in the lumen. Samuel D. Gross, in 1843, and W. S. Halsted, in 1887, completely demonstrated that no intestinal suture was safe unless all or a portion of the submucosa was included in its grasp. Halsted advised a suture that would split, but not penetrate, this layer. The impossibility of doing this with any regularity is easily seen when it is recalled that the diameter of a No. 8 sewing-needle—the kind ordinarily used in intestinal work—is six times greater than the thickness of the submucosa in the small intestine, which is about one two-hundred-and-fiftieth of an inch. In the duodenum, as Brunner's glands are in this layer, such a suture, even if it always merely penetrated without perforating the submucosa, would clearly be dangerous.

But, aside from any theory, there are abundant practical

proofs of the safety of the through-and-through suture. In Maunsell's operation this principle of penetrating all coats is used, and there have been thirty-one cases operated on with only three deaths. In 1901, Connell reported nineteen cases operated on by his method with only three deaths,—all due to shock and not to a failure of the method. In a paper read before the Mississippi Valley Medical Association in October, 1902 (*American Medicine,* Vol. v, p. 135), he gives a table of sixty-four cases operated upon according to his method by different surgeons. Of this number there were twenty-one deaths, but in only one instance was the operation at fault, all the others dying from shock, previous peritonitis, or some other cause not attributable in any way to the Connell method. So it seems proven that so long as the knots are not exposed on the serosa, an interrupted suture which penetrates all coats is comparatively safe from infecting by capillarity; for, if drainage occurs, it will be towards the cut ends of the thread and, consequently, the knot. The only practical way, then, to obtain a series of sutures that will hold is to have each one penetrate all coats of the intestine.

While there are some enthusiastic advocates of the continuous suture as against the interrupted in intestinal work, the advantages of the former stitch do not seem to be generally appreciated. It has been chiefly urged against this suture that it is not accurate in approximation, and that it is liable to pull loose in one or two places, and so loosen the whole row. These objections are valid when the suture takes up only the serous and muscular coats, for then it cuts or pulls through its bite; but they do not obtain when it penetrates all the coats. I have frequently seen the intestine of cadavers or dogs, when sutured with a through-and-through continuous stitch and subjected to hydrostatic pressure, rupture at a point some distance from the suture line that would still be intact.

It is a surgical axiom that rest is essential for repair. It is this fundamental principle that requires a broken limb to be immobilized, or a pleuritic chest to be strapped. This principle has been utilized in efforts to reduce peristalsis after intes-

FIG. 1.—Murphy button; thirty-six days. (After J. Henry Barbat, Jour. Am. Med. Ass'n., Vol. xxxiii, p. 126.)

FIG. 2.—Murphy button; fifty-seven days. (After J. Henry Barbat, Jour. Am. Med. Ass'n., Vol. xxxiii, p. 126.)

tinal wounds by giving opium; others, considering gaseous distention of the intestine the greater evil in loosening the stitches, have attempted to relieve this tension with saline purges. In end-to-end union of the bowel it requires but a moment's thought to see what a great advantage the continuous suture, which acts as a splint, has over an interrupted stitch. The portions of the wound between the interrupted stitches are stretched to their utmost when gas accumulates; they are alternately more or less stretched and relaxed with every peristaltic wave. All of this is impossible with a continuous suture through all coats, for, by its splint-like action, it holds the wounded intestinal margins practically immovable and in perfect contact. If distention occurs near the wound, the strain is not put upon the wounded intestine but upon the thread, and the uniform pressure which this suture maintains prevents separation of the wound margin at any point by peristaltic action.

Strictly speaking, there is no such thing as primary union in a wound. In other words, repair of all wounds, whether the healing be aseptic or not, is accomplished by granulation, though it may be so small in amount as to require microscopical demonstration. Even though plastic exudate glues a sutured intestinal wound together in a few hours (F. Mall, *Johns Hopkins Hospital Reports,* Vol. i), firm union must eventually take place by granulation. In a successfully sutured wound this process of granulation is established by the third day, and at this time the line of union is weakest, as demonstrated by hydraulic pressure by von Chlumsky, and confirmed by experiments of my own, mentioned later on. The uniform pressure on the wound margins so necessary at this critical stage is better afforded by the continuous than by the interrupted suture.

Pathologically, an ideal result in an end-to-end union would be a narrow band of approximation, of uniform width, with a minimum amount of scar tissue. It has been clearly shown by Murphy, Barbat, and others that such a result is obtained by the Murphy button (Figs. 1, 2, and 3) and similar appliances when properly and successfully used. How, then,

is this obtained? Not by mere *approximation* of serous surfaces, but by *uniform pressure upon these surfaces at every point along the margin of the intestinal wound.* This condition is perfectly filled by the continuous suture that penetrates all coats, but the interrupted suture cannot meet the requirement. Intestinal union obtained by interrupted sutures as ordinarily placed, about one-eighth inch apart, is effected differently at different points of the wound. Within the bite of the suture union is due to pressure of the suture, to the trauma inflicted by the needle, and to the inflammation excited by the presence of a foreign body,—the thread. At a point midway between the sutures, the pressure from the bite of the suture on each side in the thin intestinal tissue is practically *nil;* so union must depend solely upon extension of the inflammation due to the trauma of the needle and the presence of the thread. Such conditions, varying every eighth of an inch, cannot produce an ideal result, and, at least theoretically, may be positively dangerous.

The doctrine, as frequently taught in medical schools, that in intestinal suturing mere approximation of serous surfaces suffices, is misleading. Approximation, unless accompanied by inflammation from pressure, trauma, or the presence of a foreign body, cannot result in union, and, as pointed out above, the closest approximation and the best pathological result are obtained when there is uniform pressure along the entire wound margin. This conclusion was arrived at as the result of the following nine experiments:

Two coils of intestine were laid side by side, as in the operation for intestinal exclusion by lateral anastomosis. A row of continuous stitches from two to four centimetres long was inserted in the long axis of the bowel. At a distance of about one centimetre a second row of sutures, the same length as the first and parallel to it, was placed. The portion of the intestinal wall between these rows was in apposition, but without pressure, except near the region of the sutures.

The dogs were killed on one, two, three, four, six, and eight days after the experiments and the specimens removed, and afterwards examined and measured by a competent pathol-

FIG. 3.—Murphy button; sixty-three days. (After J. Henry Barbat, Jour. Am. Med. Ass'n., Vol. xxxiii, p. 126.)

ogist, Dr. J. S. Davis, Professor of Pathology, University of Virginia. In the first six experiments, No. 1 twisted black silk was used; in the last three, No. 2 white braided silk. This was done to determine, in addition, whether the larger size of the latter suture material would markedly cause more inflammation and exudate.

In these nine experiments, out of the first series of six, in which small black silk was used, in only two experiments did all the area included between the rows of sutures unite. Of the three experiments in which No. 2 braided silk was used, in only one instance all of the area included between the rows failed to unite. This indicates clearly that approximation alone is not sufficient to secure accurate results in every case of intestinal suture. In these nine experiments an area of intestine was thoroughly approximated, and held in this condition by the splint-like action of the continuous suture. In only four did all of the area included between these rows of sutures unite. The report of the pathologist also shows that more reaction, inflammation, and resulting adhesions occurred when a coarse silk suture was used. This is borne out by the fact that in the last series of three experiments, in which the coarse silk was used, the inflammation excited was sufficient to cause adhesion of all the area included between the sutures in two of these experiments.

A NEW METHOD OF INTESTINAL UNION BY SUTURE.

Before proceeding to the technique of the operation, it may be well to give some observations that have accumulated as the result of a moderately extensive experience in experimental intestinal surgery, both on the lower animals and the cadaver. I may preface these remarks by repeating what I have already alluded to, that, so far as the pathology of the line of union is concerned, the successful cases following the proper application of a well-constructed Murphy button or similar contrivance give an ideal result. However, as is well known, all Murphy buttons are not properly constructed nor properly applied, and, even when these conditions are complied

with, occasionally the button is retained or perforation occurs. It is generally recognized that any operation dependent upon a specially constructed mechanical device is handicapped; and it is equally true that a large foreign body left fixed in the intestinal canal may be a source of danger.

In the application of intestinal sutures, I have used a No. 7 or No. 8 ordinary sewing-needle and have found them entirely satisfactory. I have also made constant use of the thimble. Albert found the thimble of decided advantage in intestinal suturing, and it seems strange that it is so little used. It is awkward at first, but a little constant practice in ordinary sewing readily overcomes this. The thimble is considered indispensable by the most expert needle-women, and surely it must have some advantage in placing delicate intestinal sutures.

The suture material ordinarily used in this work is fine, black, twisted silk, usually No. 1. This has several disadvantages, particularly in intra-intestinal suturing. It does not fill the needle puncture completely. Though from its natural elasticity the submucosa tends to diminish the size of this puncture, still, it would be safer to have a thread that would completely block it and prevent all possibility of leakage. Fine silk cuts, and so may enlarge the puncture, and for this reason, aside from its tensile strength, cannot have as firm a hold as a larger thread. Twisted silk is liable to tangle. My experience has been that the best results are obtained by using braided silk of the largest size that can be gotten through a No. 7 or No. 8 needle. This is No. 2 braided silk, and has great tensile strength, fills the needle hole completely, does not cut out, and does not easily tangle. While this is particularly applicable to sutures that penetrate all the intestinal coats, it is also partly true of stitches of the Lembert type.

There is a great deal of difference of opinion in regard to what should be the name of the operation by which a breach in the continuity of the intestinal canal is repaired, when such repair is done by an end-to-end method. The term "anastomosis," as has been pointed out by Senn and others, is certainly not appropriate in this connection. Its use implies the forma-

tion of some indirect opening to compensate for obstruction in the main channel. Hence, the removal of such obstruction and the re-establishment of the former channel cannot properly be called an "anastomosis." Circular enterorraphy is equally objectionable. Enterorraphy means simply that the intestine is sutured, so there would have to be another term to designate end-to-end union of the intestine by mechanical appliances, such as Murphy's button. Besides, circular enterorraphy implies merely suture of the intestine in a circular manner. In the operation for prolapse of the rectum, in which the sigmoid flexure is sutured to the abdominal wall, if such sutures are inserted in a circular direction, "circular enterorraphy" could certainly be applied to this procedure. The term end-to-end union of the intestine seems to be free from the objections just mentioned, and is used in this paper.

The operation as originally conceived appeared first in the *New York Polyclinic,* December, 1897. After this preliminary report was published, further experimental work done on eleven more dogs showed that it was difficult to invaginate the mucosa with an overhand stitch, and also that the outer row of sutures was unnecessary, and in experimental work, at least, positively dangerous. In four of these eleven experiments, the outer row caused such a large diaphragm to be turned in that death resulted from obstruction.

The technique as now recommended and performed successfully on nineteen dogs is as follows: The intestinal clamps are placed, or a single knot of a soft rubber tube used, as recommended by Ballance and Edmunds, to obtain coprostasis. The mesentery is incised; in resection, a triangular portion may be removed. The vessels at the mesenteric border of the intestine are clamped before being cut. The forceps that clamp the vessels are also made to include both layers of peritoneum as they separate from the mesentery to encircle the bowel. The tissue within the bite of the forceps is ligated with fine silk, so drawing the peritoneum over the area of bowel usually devoid of a serous coat, and at the same time closing the vessels. This stage is shown in Fig. 4. Next, the bowel is divided, or re-

FIG. 4.

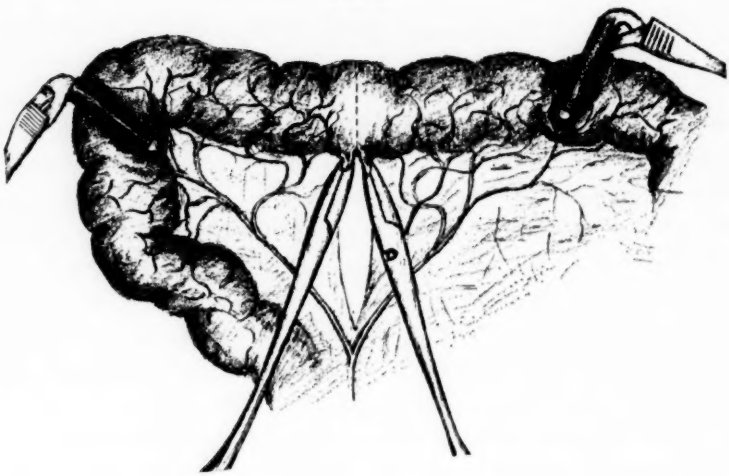
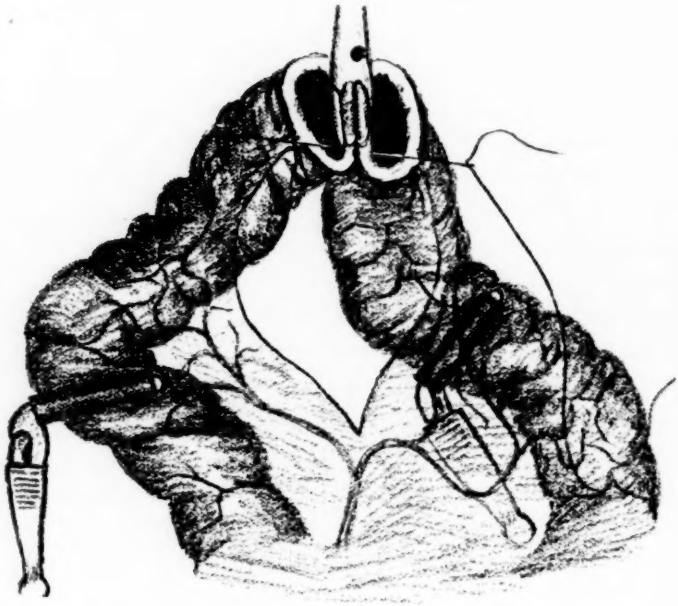


FIG. 5.



sected, as the case may be, and the convex borders placed in contact and held in this position with a hæmostatic forceps. An ordinary No. 8 sewing-needle threaded with No. 2 braided silk transfixes both walls of the intestinal ends about half-way between the mesenteric insertion and the forceps (Fig. 5). The suture is drawn through and tied. A portion of the intestinal walls forming a crescentic area, the centre of which is grasped by the hæmostatic forceps, is now cut out with scissors, by cutting about one-third of an inch at a time and suturing the cut edges together with a continuous circular (overhand) stitch, penetrating all coats, then cutting another one-third inch and suturing, and so on until the crescentic area is excised (Fig. 6).* The needle is inserted about eight times to the inch, and moderately firm tension is constantly kept on the thread with the left hand. When this crescentic area has been removed, and the margins from which it was cut have been sutured in the manner described, the needle is thrust directly through the intestinal wall just to the right of its last puncture and emerges from the serosa. The character of the stitch is now changed to a Cushing right-angled continuous suture, penetrating all coats, and readily inverts the remaining margins of the wound (Fig. 7). This stitch is continued (Fig. 8), with moderately firm traction on the thread. When the first knot is reached, it is invaginated, and the suture continued by two more insertions of the needle. With these last two insertions of the needle as secure a hold as possible is obtained without penetrating to the mucosa. The very last insertion of the needle is in the reverse direction of the other insertions, so that when the knot is tied it is partly buried (Fig. 9). If desired, it may be completely buried by a Halsted stitch, though I have never thought this necessary. After this suturing is completed, scarcely any of the thread can be seen, except a portion of the knot, unless the bowel ends are pulled upon. The bowel is then turned to its natural position, and with another needle similarly

* Or the continuous Connell suture may be used, suturing first for a few stitches and then cutting.

FIG. 6.

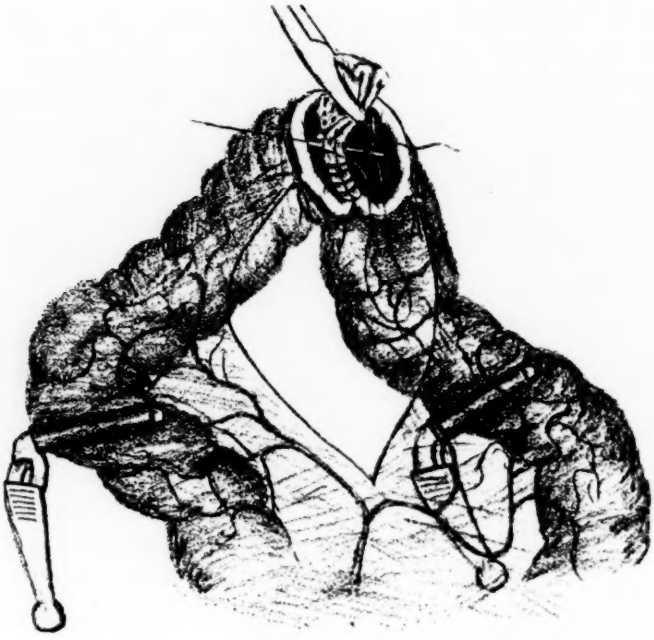


FIG. 7.

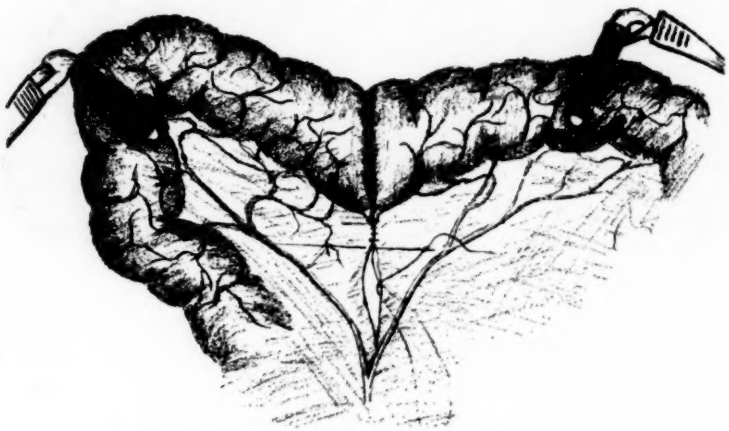
FIG. 8.

FIG. 9.

threaded the mesentery is sewed up with a continuous stitch (Fig. 10). The needle is inserted in the mesentery at its junction with the bowel, and the first knot when tied acts as a mesenteric stitch. It is placed close to the bowel, though no attempt is made to include any portion of the intestinal wall in its grasp, as in the Mitchell, Heamner or Halsted mesenteric stitch.

Nineteen dogs were operated on by this method without a death.

FIG. 10.



In the few instances in which an insufficient lumen or too many adhesions resulted, the cause of the former fault can always be attributed to the placing of an extra row of reinforcing sutures or to invaginating too much intestine at the mesenteric border. I feel quite certain that both of these things were frequently done unnecessarily. However, the results of these experiments, both as to lumen and as to adhesions,—upon which Halsted lays so much stress,—can be favorably compared with those of experiments from any other method of intestinal union. This method has many advantages.

First of all, it is efficient, as demonstrated by nineteen consecutive operations on dogs by this technique without a death, and by the manner in which it has resisted hydrostatic pressure in specimens both from dogs and cadavers.

It requires no complicated apparatus or special mechanical device for its performance. A thumb forceps, two hæmostatic forceps, a pair of scissors, needle, thread, and thimble are all the instruments needed. In fact, the hæmostatic forceps can be readily dispensed with, for the first two ligatures can be applied with needle and thread, and through the crescentic area to be excised a thread can be passed with a large needle, firmly tied, and used as a guy-thread in place of the forceps while cutting out this crescentic area. So all that is absolutely necessary to perform this operation is a pair of scissors and needle and thread. As intestinal union is pre-eminently an emergency operation, this fact should be decidedly in its favor.

Though W. A. Evans has demonstrated that the danger from stricture following intestinal resection is greatly overrated, still, it cannot be entirely eliminated, for some well-authenticated cases are on record. At any rate, diaphragm formation is a real danger, at least in experimental work, as is well demonstrated by four deaths in one of my series of experiments. Post-mortem showed each death to have been caused by obstruction from inverting too much intestine. Another dog died from the same cause on which a Halsted end-to-end union had been performed. All of the end-to-end methods in which serous coats are apposed must have some diaphragm formation, for the principle of approximating serosa to serosa necessarily implies inversion of a portion of the intestinal wall. The diaphragm may be very slight, as Ballance and Edmunds state in the case of Maunsell's operation, or extensive, as when two or more rows of sutures on the Lembert principle are used. However, it cannot be claimed that a diminution of the intestinal caliber at the point of suture is a desirable thing, even though such a diminution be slight. It must be borne in mind that this means increased pressure and friction at the point of union; and, if the sutures are not pulled out or their hold injured thereby, there is always a future possibility of ulceration or even malignant invasion at this point, unless the diaphragm turned in atrophies, or unless the stitches loosen and the intestine straightens out, which F. Mall says occurs about the fourth

week. This change, however, does not always occur, as is demonstrated by a photomicrograph of J. Henry Barbat (*Journal American Medical Association,* Vol. xxxiii, p. 128), showing a diaphragm, without any attempt at straightening of the intestine, ninety-nine days after a suture operation (Fig. 11). It seems unlikely that a diaphragm which has existed for this length of time, and in which union has become firm and well organized, will ever straighten out in the manner indicated by Mall. In my operation, owing to the excision of the crescentic area, the diameter of the intestine at the point of union is always greater than its normal diameter.

I have attempted to demonstrate elsewhere in this paper that the continuous suture penetrating all intestinal coats is the best. In the operation described this suture is used, and it is unnecessary to repeat here the arguments in its favor, though I may add that it controls bleeding, sometimes a point of no little consequence. It has been objected that this suture, while working into the lumen of the bowel, may hang partly attached for weeks before being cast off, and during this period prove a source of obstruction. In a number of experiments, after observing the suture in all stages, I have never seen it act in this manner, nor has any one else, so far as I can learn. I have never seen any accumulation of fæcal matter with the suture as nucleus; and if this does not happen in dogs with coarse diet and intestines of small caliber, it surely should not occur clinically. The objection is purely a theoretical one, not borne out by experimental or clinical evidence.

This operation can be very quickly performed, and ordinarily takes but little, if any, longer than the application of a Murphy button. I have performed it in eight minutes, and can do it in from twelve to fourteen minutes without any undue haste.

Finally, the technique is quite simple and, unlike the Connell and some other methods, is easy to learn and difficult to forget.

FIG. 11.—Suture, ninety-nine days. Showing result usually obtained by suture. (After J. Henry Barbat.)

TESTS OF DIFFERENT METHODS OF INTESTINAL UNION BY SUTURE.

In the experimental work of von Chlumsky along this line (*Centralblatt für Chirurgie*, 1899, Vol. ii, pp. 33–37), suturing was done according to the method followed for many years in Mikulicz's clinic, which corresponds essentially to Albert's double suture, employing continuous sutures. In addition, in other cases, the buttons devised by Murphy, Frank, and other surgeons were employed, the author's description being exactly followed.

At first, the strength of the intestinal union was tested by means of direct mechanic traction at one end of the bowel-loop and the fastening of weights to the other end. These experiments were inexact and unsatisfactory.

Much more exact, however, were the results of those experiments in which was ascertained the amount of pressure which the union could stand without breakage. These tests could be easily made and the pressure conveniently measured; in addition, the results were more satisfactory, as the least leakage was readily recognized by the escape of the fluid. Of course, even this method is not entirely free from criticism, and cannot be used in the human subject. The same operations were performed on fresh human cadavers and upon dogs for purposes of comparison.

The result of von Chlumsky's experiments showed that an intestinal union was weakest in the third and fourth days after operation, being comparatively strong after twenty-four hours.

In working on the experiments to be described, I have used a technique somewhat different from that of von Chlumsky. It was my endeavor to select two typical methods of end-to-end intestinal union by suture, and to test these as representing practically all classes of end-to-end union by suture, except those in which invagination forms an essential part, as in the operations of Morisani, Kelly, Harris, and Moreau. As a type of sutures of the Lembert class, the Halsted end-to-end

method was taken. The method of F. G. Connell was selected as representing the class of operations in which all coats are penetrated and the knots tied within the lumen. The operation above described was compared with these two types.

These operations were performed on dogs, and, wherever possible, all three were done on the same dog at the same time, so that the idiosyncrasies of the individual dogs, constitutional difference in resistance, etc., might be eliminated as far as possible. Whether the operations to be tested at the expiration of the same time were performed on the same dog or not, in all instances dogs of about equal weight were chosen, and conditions made to be identical so far as possible. Only those dogs in which the operation was successful, and in which general peritonitis did not result, were used in making the tests. The tests were made by water. It was observed that a pressure of eleven feet of water always ruptured the muscular and peritoneal coats if it was maintained for four minutes. This was taken as the maximum, and when a union would stand a pressure of eleven feet of water for four minutes without leaking, the result is recorded as eleven feet plus. About six inches of intestine were removed in each experiment, the site of operation occupying the middle of this section. One end was closed with a clamp, and into the other end was securely tied the nozzle of an irrigator filled with colored water. The intestine was gradually lowered about six inches at a time, and kept in this position for one-fourth of a minute. If leakage did not occur, it was lowered six inches more, and so on until the maximum of eleven feet was obtained, unless leakage occurred before this point was reached. In the latter case, the distance from the point at which leakage occurred to the level of the water in the irrigator was measured and recorded as the pressure which this particular operation bore.

EXPERIMENT I.—Black, short-haired, mongrel, male dog, medium weight. Connell operation, interrupted sutures. This operation was found rather difficult in the dog, being considerably harder to perform than on the cadaver, on account of the thickness of intestinal wall and eversion of the mucosa, which makes approximation more difficult, particularly in tying

the last knot. Halsted mattress suture end-to-end method was also performed on this dog. Specimens removed after twenty-four hours showed the lumen in the case of the Halsted operation almost obliterated. No peritonitis or leakage from either operation. By hydrostatic pressure, it was impossible to rupture the Connell method with eleven feet of water. The Halsted method leaked at five and one-half feet.

EXPERIMENT 2.—Short-haired, black and white, mongrel, male dog, medium weight. The new operation performed. Time, fourteen minutes. Specimen removed after twenty-four hours. Some omental adhesions to suture line. Leakage occurred at five and one-half feet of hydrostatic pressure.

EXPERIMENT 3.—Heavy-set, black, male dog, medium weight. Connell and Halsted methods performed as in Experiment 1. The new operation also performed, taking only eight minutes. Specimens removed after two days (forty-eight hours). Connell method, eleven feet plus; Halsted method, three feet; new method, five and one-half feet.

EXPERIMENT 4.—Long-haired, black bitch, medium size. Connell and Halsted methods as in previous experiment. New operation also performed. Time for latter, nine minutes. Dog died after two days from general peritonitis, from leakage at the last stitch in the Connell operation. The other two methods showed no leakage.

EXPERIMENT 5.—Liver and white, setter, male dog, medium size. Connell and Halsted methods as in preceding experiment, and new method. Time for latter, twelve minutes. Specimens removed after three days, all of them in good condition. Connell method leaked at three feet, Halsted at three feet, and new method at three feet.

EXPERIMENT 6.—Long-haired, brindle and white, male dog, medium size. Connell, Halsted, and new methods as in preceding experiment. Time for the latter, twelve minutes. Dog died after thirty-six hours of general peritonitis, from leakage at a point in the suture line of the Connell method. In this instance it was my fault and not a fault of the method, as several of the stitches were tied unduly tight. The other two operations showed no leakage.

EXPERIMENT 7.—Shepherd male dog, medium size. Connell, Halsted, and new operation performed as in preceding experiment. Time for latter, twelve minutes. Specimen removed after four days. Connell method leaked at ten and one-half feet, Halsted at five feet, new method at ten feet.

EXPERIMENT 8.—Long-bodied, long-haired, black, male dog, medium size. Connell, Halsted, and new operation as in preceding experiments. Time for latter, fifteen minutes. Specimens removed after six days. Connell method, eleven feet plus; Halsted, eleven feet plus. New method leaked at eleven feet.

EXPERIMENT 9.—Heavy-set, yellow cur, male dog, medium size. Connell, Halsted, and new operation performed as in preceding experiments. Time for latter, thirteen minutes. Specimens removed after eight days. Connell method, eleven feet plus; Halsted, eleven feet plus; new method, eleven feet plus.

The results of these experiments clearly indicate that a suture through all coats of the intestine is stronger during the first six days than a suture that attempts to include merely a portion of the submucosa. While the Connell method stands more pressure at the end of the first and the sixth day, the new method stands practically as much pressure as the Connell operation during the critical time in intestinal union, which is the third and the fourth day.

INDEX TO SURGICAL PROGRESS.

HEAD AND NECK.

I. An Improved Method of Treating Congenital Fistulæ of the Neck. By PROFESSOR FRITZ KÖNIG (Altona). Congenital fistulæ in the neck arising from faulty closure of the second branchial cleft are infinitely more common than those originating from the first and third clefts. When complete, they usually form a canal running from Rosenmuller's fossa (behind the tonsil) under the digastric muscle through the cervical fascia and platysma to open through the skin between the sternomastoid muscles. Recurrence after operation is common, because excision of the pharyngeal end of the fistula is very difficult. In the case of a child, von Hacker excised the outer half of the fistula, passed an eyed probe through the pharyngeal half, and by this means drew a thread previously fixed to the outer end of this portion of the fistula into the pharynx and out of the mouth. By traction on the thread it was easy to pull the remnant of the fistula "outside in" into the mouth, exactly as one everts the finger of a glove in pulling it off the hand. The fistula was thus excised easily. When inflammation has made the fistula adherent to the surrounding tissues, such a procedure becomes impossible, and in most cases this condition is present. Fritz König has devised the following operation, which he finds successful.

By dissection, mobilize the fistula to a point above the digastric; above this free it by blunt dissection with the finger to a point close to the oral mucous membrane. Open the mouth with a Whitehead speculum. Pass a strong curved probe through the wound into the mouth at a point anterior and inferior, but close to, the tonsil. In doing this, it will be necessary to incise the oral mucosa. Tie a silk thread to the outer end of the fistula, and

with the probe pull the thread into the mouth. Traction on the thread will pull the mobilized fistula into the mouth. Suture the side of the fistula to the edges of the wound in oral mucosa and cut away the protruding portion of the fistula. Close the external wound *secundem artem.* The result of the operation is that all communication between the fistula and the skin is cut off, while the remnants of the fistula remain as a harmless passage opening both behind and in front of the tonsil. The operation avoids the difficulty of excising the pharyngeal end of the fistula, and the results are excellent. König has applied the same principle in excising certain blind internal rectal fistulæ, and has found it beneficial.—*Archiv für klinische Chirurgie,* Band lxx, p. 1008.

JOHN F. BINNIE (Kansas City).

ABDOMEN.

I. The Operative Technique of Prolapsed Invaginated Intestine. By PROFESSOR DR. F. HOFMEISTER (Tübingen). It is not rare in a case of intussusception to feel the invaginated mass in the rectum, and it occasionally happens that the mass protrudes through the anus. Leichtenstern has collected 222 cases of intussusception, with forty-one cases of prolapse and thirty-one cases of the tumor mass being palpable per rectum. Braun has tabulated sixty-five cases, with nine cases of prolapse, and twenty-two cases where the mass could be felt per rectum. Rydygier, however, in eighty-six observations reports only two cases of prolapse and four of the tumor in the rectum.

Most cases occur in small children, with acute invagination. The time from the onset of the disease until the appearance of the prolapse varies from two days to one month. In adults it occurs mostly in chronic cases, and the prolapse is not seen for a number of weeks.

The author reports two cases.

CASE I.—Patient aged thirty-two years. Male. Prolapse on

tenth day of disease. Prolapsed mass twenty-five centimetres in length. At the apex of the mass the ileocæcal orifice was seen.

Median abdominal section having been made, the intussusceptum was pulled out as far as possible, and the gut divided between two intestinal clamps at a point just above the intussuscipiens. Proximal stump closed with purse-string suture.

The mesentery of the intussusceptum was sectionally ligated and divided. Thereupon the intussusceptum disappeared within the intussuscipiens, leaving the mesentery of the middle cylinder easy of access.

Ligature and division of this mesentery.

Purse-string suture passing through all the layers at the entrance of the intussuscipiens. Circular incision through the wall of the intestine proximal to the suture. End of stump closed by pulling up of suture.

Lateral anastomosis of the two stumps, so arranged that the waves of peristalsis passed in the same direction. Intussusceptum removed per rectum. Length of resected gut was 130 to 140 centimetres. Patient made a good recovery.

Case II.—Case of long standing. Patient aged forty-two years. Prolapsed invaginatio sigmoideo-rectalis. On apex of prolapsus a carcinomatous growth.

Operation (Professor Küttner). Seat of invagination too low down to be reached by abdominal section. Perineum and rectovaginal septum dissected up four centimetres. Mass pulled down so that highest point of intussuscipiens could be reached. The anterior half of the circumference of the intussuscipiens was cut through at this point, *i.e.*, mucosa; then muscularis, and, finally, the serosa, thus opening the peritoneal cavity. The serous surface of the free edge of the intussuscipiens was immediately sutured to the serosa of the intestinal wall just above the intussusceptum, thus closing the peritoneal cavity again. Then the anterior half of the circumference of the intussusceptum was cut through, and the muscularis and mucosa of the intussuscipiens

were joined by layer suture to the free edge above. Then followed division of the posterior half of the circumference and sectional ligature and division of the mesosigma. Serous surfaces of the divided portions sutured as anteriorly, removal of intussusceptum, and suture of muscularis and mucosa.

There remained an invagination of about three centimetres in length, at the apex of which was seen the circular line of sutures. This invagination could be easily reduced. The vaginal mucous membrane, rectovaginal septum, etc., were repaired.

Patient recovered. Died one month later from other causes. Field of operation entirely healed. No stenosis.

In discussing the method of intestinal resection in cases of invagination, the author believes that in many cases it is better to simply resect the invagination, and not resect the sheath as well, the mass being removed "per vias naturales." This is simple in cases of prolapse. It is argued that if an ileocæcal segment a foot long can prolapse through the rectum in a few days, despite the restraining mesentery, and, as was seen in Case I, the freed invaginatum sinks rapidly into the rectum, then with an open abdomen, in the majority of cases, it will be easy to push the intussusceptum into the colon, and so on out. There is less danger of infection than in opening the intussuscipiens.

The method recommended by Bier, *i.e.*, making a longitudinal opening in the intussuscipiens near the neck and tying off *en masse* the intussusceptum, and then dividing it below the ligature, and using the opening for lateral anastomosis, is held to be unsafe on account of the possibility of the ligature slipping and retraction of the stump. Of great advantage, however, would be a modification of this.

(1) The operator begins by division of the gut, pulled out as far as possible, and sewing up of the proximal stump.

(2) The distal stump is allowed to drop down deep into the sheath of the invagination, and the open end of the sheath is closed with purse-string suture.

(3) Longitudinal opening in the sheath a few centimetres below its neck, ligature and division of its inner cylinder as high up as possible, and lateral anastomosis of sheath with proximal stump.

This gives a much more secure ligature than by the method of Bier. It differs from the first described method only in that the stump of the mesentery belonging to the inner cylinder is fixed in the blind end of the stump.

This plan of operation is simply the application of the Frey method of intestinal resection to the condition of invagination.—*Beiträge zur klinischen Chirurgie*, Band xxxix, Heft 1.

PAUL MONROE PILCHER (New York).

II. (a) Modified Maydl's Method of Operating for Relief of Congenital Exstrophy of the Bladder. (b) Cholecystenterostomy combined with Entero-anastomosis. The two operations noted may be considered together, as they are based on precisely the same idea.

Maydl's operation in ectopic bladder consists in implanting the ureters and the adjacent portion of bladder-wall into the gut. The great danger of this procedure consists in the ascent of infection to the kidneys, and consequent nephritis and death.

(*a*) BORELIUS (Lund, Sweden), to avoid this accident, implants the base of the bladder with the ureters into the apex of the Ω of the sigmoid flexure, and makes an anastomosis between the afferent and efferent segments of the sigmoid. The result is that the intestinal contents do not pass through that part of the sigmoid into which the urine pours, and hence the dangers of infection are at least greatly lessened.

[Granting the correctness of Borelius's idea, would it not be wise to throw around the afferent segment, distal to the anastomosis, a constricting ligature of wire, as Fowler has suggested in gastro-enterostomy, or a purse-string suture, and so absolutely

insure against fæcal contamination? J. F. B.]—*Centralblatt für Chirurgie,* 1903, p. 780.

(*b*) MARAGLIANO reports that the same principle is used by Professor Fedor Krause to prevent the ascent of infection to the gall-bladder in cases of cholecystenterostomy. An anastomosis is effected between the loops of gut leading to and from the gall-bladder. [In this case, also, occlusion of the afferent loop might be a valuable precaution.—J. F. B.]—*Centralblatt für Chirurgie,* 1903, p. 941.

III. Turning up the Arch of the Ribs for Facilitating Operative Procedures in the Hypochondriac and Epigastric Regions. By PROFESSOR GEORGE MARWEDEL (Aachen). The rigidity of the lower margin of the thorax interferes much with access to the upper surface of the liver, the dome of the diaphragm, and the lower end of the œsophagus. Marwedel has devised a method of overcoming this difficulty, has used it frequently on the cadaver, and found it successful on the living. In operating on the upper surface of the liver the abdomen is opened by a curved incision parallel to the rib border, and stretching from the ensiform cartilage to the tenth rib. If in the upper edge of the wound one separates the rectus and external oblique muscles from the internal oblique and transversalis, one exposes the costal margin. It is easy to expose in this split (between the muscles) the cartilage of the seventh rib and to divide it near its sternal end. By blunt dissection downward and outward it is easy to expose the junction of the bone and cartilage of the ninth, eighth, and seventh ribs, and to divide them there. Having done this, the loosened portions of ribs and the soft parts over them are easily retracted upward over the thorax, and free access to the hypochondrium is obtained. On the left side a similar procedure gives free access to the upper part of the stomach and cardia.—*Centralblatt für Chirurgie,* 1903, p. 939.

JOHN F. BINNIE (Kansas City).

EXTREMITIES.

I. Dupuytren's Contracture. By G. DOBERAUER (Prag). The use of infiltration anæsthesia (Schleich) for this operation is dangerous, since it disposes to gangrene of the skin. The use of Esmarch's bandage is of great service; yet it should be removed before the close of the operation and each vessel ligated, since hæmatomata may also cause gangrene of the skin by their pressure, and for like reasons tight bandages are to be avoided. Inasmuch as gangrene of the wound edges would be followed by ulceration and keloid formation just over the tendons, Lotheisen advocates placing the incision along the ulnar margin extending over to the thenar eminence; a flap is dissected up and the fibres of the palmar fascia removed. The author believes this method limited to cases where the skin is not involved. Where longitudinal palmar incisions are called for, and they lie close together, thus disposing to gangrene, they should be made at separate sittings.

Recently, Lexer has even gone so far as to extirpate the entire skin overlying the contracture, replacing it by pedunculated flaps obtained from the abdomen or by Krause's skin flaps. Kocher's method, though, is regarded as the best procedure.—*Beiträge zur klinischen Chirurgie,* Band xxxiv, Heft 1.

II. Varicose Veins of the Leg. By DR. FELIX FRÄNKEL (Nürnberg). The treatment of varicose veins of the leg is thus summarized. In most of the instances, patients afflicted with varicose veins are in need of no other therapy than the use of a compressing bandage.

In contrast to this class of cases is that class demanding some operative procedure, the indications for which are œdema, severe pains, hæmorrhages, ulcerations, and persistent eczemas. The most expedient and radical procedure, in the author's judgment, is extirpation of the dilated vein in its greater extent, together

with resection of a certain extent of the internal saphenous vein just below the saphenous opening. Prior to performing this extirpation, the veins are made more conspicuous by applying a rubber constrictor, moderately tight, to the thigh. In order to obviate the possibility of gangrene of the skin, the veins are not dissected out sharply from the skin, but are torn out bluntly. All bleeding points are secured and ligated with fine oo silk ligatures. The long skin incisions are adapted with the metal clamps of Michel. The limb is placed on a posterior splint, and the foot of the bed is elevated two feet, according to the suggestion of Lennander, to favor the circulation and prevent thrombosis of the veins above the point of ligature.

Thirty cases were thus operated, and required, on an average, a stay of six weeks in the hospital, and in only three cases, after extirpation of three years, was the end-result unsuccessful.

Only if the condition and age of the patient militate against a narcosis is this extirpation of the veins contraindicated, and the operation of choice then is the Trendelenburg ligation of the saphenous vein close to its entrance into the femoral, and resection of this vein for four inches in the peripheral direction.—*Beiträge zur klinischen Chirurgie,* Band xxxvi, Heft 3.

III. Transplantation of Skin Flaps, Krause's Method. By H. WIDMAN (Nürnberg). Thiersch's skin grafts, even under the most favorable conditions, leave a cicatrix that becomes white, and the resultant scar, being merely covered with regenerated epithelium, has none of the very desirable features of a normal skin. In areas where cosmetic effect is sought, and where pliability of the skin overlying the joints is a desideratum, nothing but normal skin will suffice. This can be effected by the method of transplanting areas of skin.

The requirements for this are, above all, an exquisite asepsis and thoroughly dry condition of the site upon which the graft is to be transplanted. The usual procedures for cleansing having

been proceeded with, the hands of the operator, as well as the skin of the patient, are first rubbed with sterilized saline solution and then rubbed perfectly dry. The instruments should also be kept dry. The skin should be chosen from such parts as are free from hair; the flaps are outlined in an elliptical shape, and should comprise, besides the skin, a minimum of subcutaneous cellular tissue sufficient to permit of suturing the flap to the edges of the defect. After the flap is separated it should be placed on a sterilized compress to rid it of blood. The defect is to be covered by one or more elliptical flaps, and the flaps should be larger than the defect, since they tend to shrivel. For covering fingers, they need merely overlap the defect.

The dressing is of dry aseptic gauze and remains *in situ* five days. After this a boric acid ointment may be used. The flap, which at this time may have a livid color, acquires a rosy hue within a week. Six to eight weeks cover the entire time of healing.

Histological studies of such successfully transplanted areas have shown that all the elements present in the normal skin in its entire extent are preserved.—*Beiträge zur klinischen Chirurgie,* Band xxxvi, Heft 3.

IV. A New Massage Procedure. By Dr. F. Hofmeister (Tübingen). As a substitute for the massage and passive motions manually conducted, Hofmeister ingeniously effects a massage of the soft parts of the hand and wrist-joint by rhythmically plunging the hand into a bath of mercury. The mercury is contained in an iron cylinder twenty inches in height; such a vessel will accommodate two and one-half to three liters (eighty pounds) of mercury. The hand is plunged into this bath of mercury from a height of twelve to fifteen centimetres, and the bottom of the vessel is to be reached.

The mercury is covered with a thin layer of alcohol, which serves the purpose of removing dirt from the skin of the hand,

and at the same time prevents evaporation of the mercurial vapors and scattering of particles of mercury. The sittings occupy from one-quarter to one hour, and are never associated with any unpleasant after effects.

The action of the column of mercury is as follows: All parts at the same level are subjected to like pressure; the most distal parts of the hand are under the greatest pressure. Upon immersion, the venous blood and lymph are forced to move in a centripetal direction; upon withdrawal, a rush of arterial blood follows. It will be noted that this ideal massage is devoid of the least pain, so apt to be a part of manual massage; thereby a great gain for the patient has been attained. While it cannot supplant the more forcible massage procedures, it does as much, if not more than the lighter massage, for the stiffening after cellulitis of the fingers and hands. It is also of service in joint affections of the hand and wrist.—*Beiträge zur klinischen Chirurgie,* Band xxxvi, Heft 2.

MARTIN W. WARE (New York).

TO CONTRIBUTORS AND SUBSCRIBERS.

All Contributions for Publication, Books for Review, and Exchanges should be sent to the Editorial Office, 386 Grand Ave., Brooklyn, N. Y.

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ANNALS OF SURGERY,
227-231 South Sixth Street, Philadelphia.